BAC 1-11
(400 SERIES)

OPERATING MANUAL

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PREFACE

THE SCOPE OF THIS MANUAL

The BAC 1-11 (400) Operating Manual is issued by USAir to individuals and agencies whose duties make it necessary that material contained herein be available to them.

It is the responsibility of such individual or agency to maintain the manual in a current condition. A RECORD OF REVISION sheet is located in the front of the manual. After insertion of each revision, enter opposite the proper revision letter the date the revision was entered and the initials of the individual inserting the revision.

Certain changes to the manufacturer's recommendations in operating technique and procedures have been made. These differences have been found as the result of experience to be in consonance with and in the best interest of safety and good operating practice.

A LOG OF CURRENT PAGES is contained herein listing all pages and their current dates for the manual. This log may be used periodically as a checklist, provided that your manual is current through the last revision.

Errors and discrepancies should be brought to the attention of Flight Training Publications, the issuing office. Comments and suggestions to improve the content are solicited.

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PREFACE

IDENTIFICATION OF APPROVED FLIGHT MANUAL MATERIAL

Much of the material in Chapter 2 - Limitations of this manual is excerpted from the FAA-Approved Flight Manual. Where such material appears in the pages of this Operating Manual, it is identified as required by Federal Aviation Regulations.

Identification is accomplished by placing (AFM) adjacent to the applicable material.

Revision of subject material on a page is indicated by a heavy, vertical line encompassing the material indicating either addition, deletion, or revision of material. Following is a sample:

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FOREWORD

Emergency procedures set up in this manual were included only after repeated testing and investigation. They represent the best known available facts about the subject. Pilots should follow these procedures as long as they fit the emergency. However, at any time they are not adequate or do not apply, the Captain's best judgment should prevail. Only the flight crew operating the airplane at the time the emergency occurs can evaluate the situation sufficiently to make the proper decision.

The procedures are essentially the same as those contained in the FAA Approved Flight Manual. Certain changes to the manufacturer's recommendations in operating technique have been made. These differences have been found as a result of experience to be in consonance with and in the best interest of safety and good operating practice.

All crewmembers should be thoroughly familiar with emergency procedures and the location and use of emergency equipment. Any flight crewmember should be equipped to handle the emergency duties of any other crewmember.

All crewmembers must realize that the Captain is in complete charge of the airplane, and his orders are to be obeyed, even though they may be at variance with written instructions. Any potential or actual emergency situation should be immediately called to the attention of the Captain. Only he shall initiate such emergency procedures as engine shutdown, extinguishant discharge, etc. (If the Captain is absent from the cockpit, the First Officer is in command.)

Fires are obviously in the category of most urgent emergencies and require the immediate action in the earliest stages for proper control. Any warning of fire must be treated as an actual fire and fire-fighting procedures initiated. Procedures may be terminated if it can be definitely determined that no fire exists.

Needless to say, it will take the best of coordination among crewmembers to efficiently combat a fire, especially in flight. It will take almost perfect coordination among the crew to quickly evacuate the airplane if it is landed while a fire is in progress. Such cooperation plus knowledge plus self-discipline and training all stand the flight crew in good stead if they have the misfortune to experience an inflight fire.

On the following pages are outlined emergency procedures to cover many of the situations which might arise. Amplification of Emergency Checklist items is included, which explains reasons for the emergency items and how they should be accomplished. Obviously, all emergency procedures could not be included on the cockpit checklist, nor are all emergency situations which could occur covered in this material. In an emergency, any intelligent, quick action is better than delay in search of the ideal.

Emergency checklists are used in the same **Challenge** and **Response** method as the Normal Checklists, but with this additional step:

The pilot reading the checklist should read aloud **both** the **Challenge** and the **Response.** Then there should be no doubt in any flight crewmember's mind as to the correct course of action. The pilot responding has the same responsibility for checking and/or accomplishing the item responding to the Challenge as if it were not being read aloud.

CHECKLIST AMPLIFICATION

Certain procedures are divided into **Memory Items** and **Secondary Actions.** The former are those actions which must be taken immediately and which are essential to safety. These are presented in boxes on the red-bordered Emergency Checklist. The latter are those which, although part of the procedure, are not essential to safety and can be left until a more convenient time.

Memory Items on all Emergency Checklists for aircraft and Pilot's Handbook are contained in this type box:

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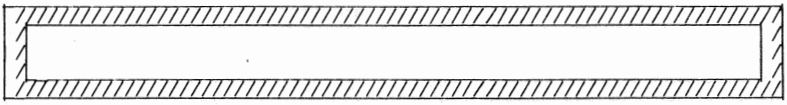
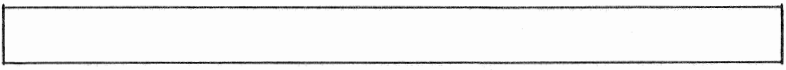
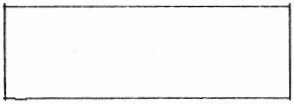
Checklist Emergency/Abnormal and Normal titles are contained in this type box:



Procedural titles are contained in this type box:



Procedural steps in the flow pattern of a particular procedure may or may not be contained in this type box:



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EMERGENCY CHECKLIST
BAC 1-11 (400)

ENGINE FAILURE

m Ignition Selector ---------- HIGH & LOW m
m Ignitors ---------- RELIGHT m

ENGINE OVERHEAT

m HP Fuel Valve ---------- SHUT m
m LP Cooling Air Switch ---------- RESET m

If overheat light remains ILLUMINATED, it is an indication of a Zone 2 overheat (external).

ENGINE FIRE

m Fire Control Handle ---------- PULL m
m LP Fuel Valve Indicator ----- CROSSLINE m
m **(Ascertain that engine shut down.)** m
m Fire Control Handle ----- TURN CLOCKWISE m
m **If fire warning persists:** m
m On After 30 seconds ------ TURN COUNTER m
m CLOCKWISE m

Silence bell and/or gear horn, if necessary.

SECONDARY ACTIONS

Throttle ---------- CLOSE
HP Fuel Valve ---------- SHUT
LP Fuel Valve ---------- CLOSE
Air Isolation Valve ---------- CLOSE
Aux. Hydraulic Pump -- SELECT FAILED SYSTEM
Engine Hydraulic Pump ---------- OFF
Aux. Hydraulic Pump Fail Light -------- OUT
Wing & Tail Anti-Icing Valves (Affected Side) ---------- OFF
Electrical System ---------- CHECK LOADS
Fuel System ---------- AS REQUIRED
Ignitors ---------- OFF
Fire Bell Cutout Switch ---------- RESET

INFLIGHT START
Emergency Restart

Ignition Selector ---------- HIGH & LOW
Ignitors ---------- RELIGHT

If engine fails to relight within 10 seconds:

HP Fuel Valve ---------- SHUT

Normal Restart

HP Fuel Valve ---------- CHECK SHUT
Throttle ---------- IDLE
Engine Anti-Icing ---------- OFF
Ignition Selector ---------- HIGH & LOW
LP Fuel Valve ---------- OPEN
Fuel Boost Pumps ---------- BOTH ON
Airspeed ---------- WITHIN ENVELOPE

220 KIAS or above:

Air Isolation Valve ---------- CLOSE
Ignitors ---------- RELIGHT
HP Fuel Valve ---------- OPEN IMMEDIATELY

Below 220 KIAS:

Air Isolation Valve ---------- OPEN
Master Valve ---------- CLOSE
Air Crossfeed Valve ---------- OPEN
Duct Pressure ------- CHECK (40 PSI MINIMUM)
Start Master Switch ---------- START
Ignitors ---------- START & MOTOR
HP Fuel Valve ---------- OPEN IMMEDIATELY

If engine fails to relight within 20 seconds:

HP Fuel Valve ---------- SHUT

When RPM has stabilized:

Start Master Switch ---------- OFF
Master Valve ---------- OPEN
Air Crossfeed Valve ---------- CLOSE
Engine Start Switch ---------- OFF
Air Isolation Valve ---------- OPEN
Engine, Wing, Tail Anti-Icing - AS REQUIRED
Electrical, Fuel, Air, & Hydraulic Systems ---------- CHECK
Warning Lights ---------- REINSTATE

APU FIRE

m APU Fire Control Handle --------- PULL m
m Check LP Fuel Valve ---------- CLOSED m
m After 10 seconds --------- TURN HANDLE m

APU Control Switch ---------- OFF
Air Delivery Valve ---------- CLOSE
Fire Bell Cutout Switch ---------- RESET
Start Master Switch ---------- OFF

SMOKE FROM AIR CONDITIONING SYSTEM

Oxygen Masks ---------- ON
Cockpit Speakers ---------- ON
Interphone Mic. Select.- NORM OR EMERG INT
Goggles ---------- ON
Air Crossfeed Valve --------- CHECK CLOSED
No. 1 MAC Valve ---------- CLOSE
No. 1 Engine Instruments ---------- CHECK

If smoke persists:

No. 1 MAC Valve ---------- OPEN
No. 2 MAC Valve ---------- CLOSE

If smoke mainly from cabin outlets, CLOSE No. 2 MAC Valve first.

SMOKE EVACUATION

Aircraft Pressurized:

Oxygen Masks ---------- ON
Cockpit Speakers ---------- ON
Interphone Mic. Select.- NORM OR EMERG INT
Goggles ---------- ON
Isolation & Master Valves ---------- OPEN
Cabin Alt. Selector - INCREASE AS REQUIRED
Cabin Rate Control -- INCREASE AS REQUIRED

Aircraft Unpressurized:

Oxygen Masks ---------- ON
Cockpit Speakers ---------- ON
Interphone Mic. Select.- NORM OR EMERG INT
Goggles ---------- ON
Both MAC Valves ---------- CLOSE
Ram Air Valve ---------- OPEN
Discharge Valve ---------- CHECK OPEN
Safety Valve ---------- OPEN

If Discharge Valve not fully open:

Air Dump Valve ---------- OPEN

RAPID OR EXPLOSIVE DECOMPRESSION

Rapid:

Air Inflow/Air Outflow ---------- CHECK

Explosive:

Oxygen Masks ---------- ON
Cockpit Speakers ---------- ON
Interphone Mic. Select.- NORM OR EMERG INT
Throttles ---------- CLOSED
Speed Brake Handle ---------- 20°
No Smoking/Seat Belt Switches --------- ON

Descend straight ahead or bank (30° max).

Passenger Oxygen Red Knob ---------- PULL
Transponder ---------- CODE 7700
F/O Oxygen Mask Mike Switch ---------- PA

When structural damage is suspected avoid high IAS and abrupt maneuvering. Complete the following:

Both Master Valves ---------- CLOSED
Air Dump Valve ---------- OPEN
Ram Air Valve ---------- OPEN

When cabin altitude sufficiently low:

Oxygen Regulators ---------- NORMAL

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EMERGENCY CHECKLIST
BAC 1-11 (400)

EMERGENCY DESCENT

Throttles ---------- CLOSE
Speed Brake Handle ---------- 20°
No Smoking/Seat Belt Switches ---------- ON
Transponder ---------- CODE 7700

Descend straight ahead or bank (30° max). Target speed is Mmo or Vmo, whichever occurs first.

MULTIPLE GENERATOR FAILURE

Either Generator ----------RESET

If unable to reset:

APU ---------- START & USE ITS GENERATOR

ELECTRICAL SYSTEM FIRE OR SMOKE

Can smoke source be located? — NO → **Prepare for loss of all but ESS AC and ESS DC buses.**
Oxygen Masks, Speakers, Interphone, Goggles ---------- AS REQUIRED
Booster Pumps ---------- ON
Fuel Crossfeed- CLOSED & INDICATOR CHKD
Normal and Emergency Lights -------- ON
Pressurization ---------- MANUAL
AC and DC Splits (#353 & #361) --- TRIP
Ins-Att Switches ---------- OFF
Flight Altitude ---- CONSIDER LOWER ALT

YES

Remove electrical power from faulty equipment or bus.

APU Generator (if running) ------- TRIP
No. 1 AC Generator ---------- TRIP

Are Captain's instruments normal? — NO → F/O's Flight Instruments -------- CHECK
HDI Selector ---------- CAPT ON ALT
Battery Switch ---------- OFF

For reinstatement procedure, refer to ELECTRICAL SYSTEM FIRE OR SMOKE, REINSTATEMENT II in the Abnormal Procedures section.

YES

HDI Selector ---------- F/O ON ALT
No. 2 AC Generator ---------- TRIP

Did smoke stop? — NO → No. 2 AC Generator ---------- RESET
F/O's Flight Instruments -------- CHECK
HDI Selector ---------- CAPT ON ALT
Battery Switch ---------- OFF

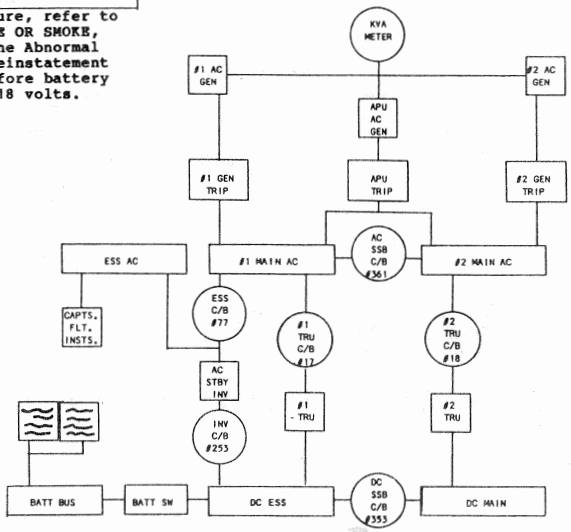
For reinstatement procedure, refer to ELECTRICAL SYSTEM FIRE OR SMOKE, REINSTATEMENT II in the Abnormal Procedures section.

YES

Continue on battery power.

NOTE: A fully charged battery will provide power in this configuration for approximately 45 minutes.

For reinstatement procedure, refer to ELECTRICAL SYSTEM FIRE OR SMOKE, REINSTATEMENT I, in the Abnormal Procedures section. Reinstatement should be initiated before battery voltage drops below 18 volts.



ENGINE FAILURE

Ignition Selector - HIGH & LOW.

Ignitors - RELIGHT. Select switches to RELIGHT to provide low and high energy ignition, hopefully to restart engine.

NOTE: Ignition normally LOW & RELIGHT for all takeoffs and landings.

Refer to SECONDARY ACTIONS, in this chapter.

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ENGINE OVERHEAT

HP Fuel Valve - SHUT. Should one engine overheat warning light illuminate, shut down the engine. Be positive in selection of HP fuel valve.

LP Cooling Air Switch - RESET. Move respective LP cooling air switch to RESET momentarily. This action should cancel the warning.

If the overheat light remains illuminated, it is an indication that the overheat condition is persisting.

NOTE: If this action causes the warning light to extinguish, the fault was LP cooling overheat (internal engine problem). If light remains ON, the fault is a Zone 2 overheat (external engine problem).

Refer to SECONDARY ACTIONS, in this chapter.

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ENGINE FIRE

Fire Control Handle - PULL. This action shuts off fuel, hydraulic fluid, and air from engine.

LP Fuel Valve Indicator - CROSSLINE. Ascertain that engine is shut down by checking engine instruments and with throttle. If indicator not crossline, select LP valve closed.

Fire Control Handle - TURN CLOCKWISE. Turning clockwise will fire first shot of extinguishant. Check discharge indicator FIRED.

If fire warning remains on after 30 seconds:

Fire Control Handle - TURN COUNTER-CLOCKWISE. Turning counterclockwise will fire second shot of extinguishant. Check discharge indicator FIRED. Do not reset fire control handle.

NOTE: Silence bell and/or gear horn, if necessary.

Refer to SECONDARY ACTIONS, in this chapter.

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SECONDARY ACTIONS

Throttle - CLOSE.

HP Fuel Valve - SHUT. Be positive in selection and identification of correct HP fuel valve. Verify with throttle. Remember, a turbine engine offers minimum drag when failed, so don't hurry. Be sure.

LP Fuel Valve - CLOSE. A back-up item, except if the HP fuel valve cannot physically be shut (possibly LP shaft failure), the LP fuel valve should be closed, preferably by the LP valve switch or by the fire control handle. If the HP valve can be shut but indications show a possibility of severe structural damage, the LP valve should also be closed.

Air Isolation Valve - CLOSE. Open crossfeed valve for one engine operation, if wing and tail anti-icing not in use. If in use, close affected side wing and tail anti-icing valves, then open crossfeed valve. Use anti-icing on good side only.

Auxiliary Hydraulic Pump - SELECT FAILED SYSTEM. Check pressure up.

Engine Hydraulic Pump - OFF.

Auxiliary Hydraulic Pump Fail Light - OUT.

Wing & Tail Anti-Icing Valves (Affected Side) - OFF. If anti-icing required, both valves ON on operating engine side only.

Electrical System - CHECK LOADS. Reduce if necessary. Start APU for use of generator.

Fuel System - AS REQUIRED. Crossfeed or transfer fuel to keep fuel balanced for landing.

Ignitors - OFF.

Fire Bell Cutout Switch - RESET. If fire bell has been isolated, push the fire bell isolation light to reconnect the bell warning circuit as soon as the fire warning ceases.

NOTES:

- The items listed on this page should be completed for a precautionary inflight engine shutdown by the flight crew or as clean up or secondary action items after an engine fire, overheat, or failure.
- In some cases, if validity of fire detection loop is in doubt, TEST the fire warning for that engine.
- After engine shutdown and the secondary action items are completed, the failed engine's throttle can be aligned with the operative engine's throttle.

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INFLIGHT START

Two inflight engine restart procedures are presented:

- An EMERGENCY RESTART procedure for use should an unwanted flame-out occur and IMMEDIATE restart is urgent.

- A NORMAL RESTART procedure for reinstating an engine that has been shut down intentionally and prompt reinstatement is not required.

EMERGENCY RESTART

Ignition Selector - HIGH & LOW.

Ignitors - RELIGHT. Monitor EGT, fuel flow, and RPM during restart.

If engine fails to relight within 10 seconds:

HP Fuel Valve - SHUT. Allow engine to drain for 1 minute. Continue with NORMAL RESTART procedures below.

NORMAL RESTART

Successful relighting has been demonstrated within the Restart Envelope in this section using CSDS assist below 220 KIAS and normal engine windmilling at 220 knots and above. However, the speed band between 215 knots and 225 knots normally should be avoided when restarting if operating conditions permit, since this is the critical start range. Emergency inflight restart can be attempted at any speed or altitude. Normal inflight restart for the two-speed ranges is given below.

HP Fuel Valve - CHECK SHUT.

Throttle - IDLE.

Engine Anti-Icing - OFF.

Ignition Selector - HIGH & LOW.

LP Fuel Valve - OPEN.

Fuel Boost Pumps - BOTH ON.

Airspeed - WITHIN ENVELOPE.

220 KIAS or above:

Air Isolation Valve - CLOSE.

Ignitors - RELIGHT.

HP Fuel Valve - OPEN IMMEDIATELY.

(cont'd.)

INFLIGHT START (cont'd.)

NORMAL RESTART (cont'd.)

Below 220 KIAS:

Air Isolation Valve - OPEN.

Master Valve - CLOSE.

Air Crossfeed Valve - OPEN.

Duct Pressure - CHECK (40 PSI MINIMUM).

Start Master Switch - START.

Ignitors - START & MOTOR.

HP Fuel Valve - OPEN IMMEDIATELY.

Monitor EGT, fuel flow, RPM, and oil pressure during restart.

If engine fails to relight within 20 seconds:

HP Fuel Valve - SHUT. Allow engine to drain for 1 minute before making another start attempt.

When RPM has stabilized:

Start Master Switch - OFF.

Master Valve - OPEN.

Air Crossfeed Valve - CLOSE.

Engine Start Switch - OFF.

Air Isolation Valve - OPEN.

Engine, Wing, and Tail Anti-Icing - AS REQUIRED.

Electrical, Fuel, Air, and Hydraulic Systems - CHECK.

Warning Lights - REINSTATE.

NOTE: In the event that an engine's fuel dip system had malfunctioned and the switch is in the ARM BOTH position, the engine might not relight. Select the switch to OFF or TTC only as appropriate.

Since failure to relight may be due to failure of the high energy ignition system, any further attempt to start the engine should be made within the low energy ignition altitude/airspeed envelope shown on the RELIGHT ENVELOPE in this section.

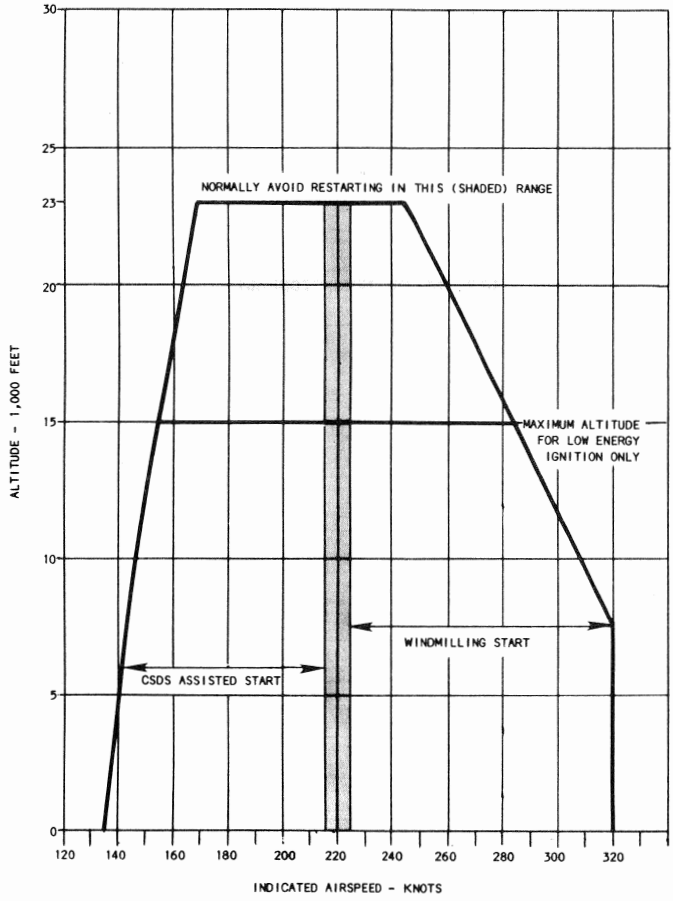
(cont'd.)

Supplied by Jeppesen Sanderson

INFLIGHT START
(cont'd.)

RELIGHT ENVELOPE

NOTE: Windmilling RPM - The characteristics of this engine are such that there are large variations in engine windmilling RPM between individual engines at given airspeeds and altitudes. Therefore, attempting to use windmilling RPM as a check on engine condition before restarting will not produce valid results.



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OIL LOW PRESSURE LIGHT ON (Not on Checklist)

If an oil low pressure warning light illuminates, check the oil pressure indicator. If the gauge confirms the warning, shut down the engine IMMEDIATELY. Should the pressure be normal, a false warning may be suspected, but the engine should be monitored for the remainder of the flight.

EXCESSIVE EGT (Not on Checklist)

Throttle back the engine. Should this prove unsuccessful, shut down the engine.

ENGINE FIRE ON-THE-GROUND (Not on Checklist)

NOTE: Engine shutdown and fire-fighting procedures on the ground are basically the same as inflight procedures. However, other systems may also be shut down in the interest of safety and an effective evacuation.

Fire Control Handle - PULL.

LP Fuel Valve Indicator - CROSS-LINE. If indicator not cross-line, select valve CLOSED.

Fire Control Handle - TURN CLOCKWISE. Turning clockwise will fire first shot of extinguishant. Check discharge indicator FIRED.

If fire warning light remains illuminated after 30 seconds:

Fire Control Handle - TURN COUNTER-CLOCKWISE. Turning counter-clockwise will fire second shot of extinguishant. Check discharge indicator FIRED.

Secondary Actions:

Throttle - IDLE.

HP Fuel Valve - SHUT.

LP Fuel Valve Switch - CLOSED.

Engine Start Master Switch - OFF.

All Fuel Booster and Transfer Pumps - OFF.

Auxiliary Hydraulic Pumps - OFF.

Engine Hydraulic Pump - OFF.

Engine Anti-icing Valve - OFF.

Speedbrake Handle - FULL FORWARD.

Flaps - 45°.

Brakes - PARKED.

Operative Engine and APU - SHUTDOWN.

Systems - MONITOR SHUTDOWN.

If fire continues:

Ground Evacuation - INITIATE, IF REQUIRED.

LANDING GEAR FIRE ON-THE-GROUND (Not on Checklist)

Ground Evacuation - INITIATE.

Advise Flight Attendants - DO NOT USE OVERWING EXITS.

Supplied by Jeppesen Sanderson

APU FIRE

APU Fire Control Handle - PULL. This shuts off fuel at the APU and fuel tank.

LP Fuel Valve - CHECK CLOSED. This is a double check that unit was shut down.

After 10 seconds:

APU Fire Control Handle - TURN HANDLE. This delay allows fuel to evacuate lines and turbine to spin down, so it doesn't exhaust extinguishant when discharged in APU. Check APU discharge indicator.

APU Control Switch - OFF. This is merely a clean up item.

Air Delivery Valve - CLOSE. This is merely a clean up item.

Fire Bell Cutout Switch - RESET.

Start Master Switch - OFF. This is a clean up item in case fire had occurred during start of APU.

If APU fire continues:

Land at nearest suitable airport. Accomplish emergency landing procedure and initiate ground evacuation procedure if required.

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APU FIRE ON-THE-GROUND (Not on Checklist)

APU shutdown and fire-fighting procedures are basically the same as those procedures for inflight; however, other systems may also be shut down in the interest of a safe and effective evacuation.

TO EXTINGUISH FROM FLIGHT DECK

APU Fire Control Handle - PULL. Check LP fuel valve CLOSED.

After 10 seconds:

APU Fire Control Handle - TURN.

SECONDARY ACTIONS

APU Control Switch - OFF. Start indicator "black".

Air Delivery Valve - CLOSE.

Air Crossfeed Valve - CLOSE. Indicator SHUT.

Systems and Engines - SHUT DOWN, AS NECESSARY.

If APU fire continues:

Initiate Ground Evacuation procedure, if required.

TO EXTINGUISH FROM EXTERNAL SHUT DOWN PANEL

APU Shutdown Switch - FIRE.

APU Extinguisher Switch - EXTINGUISH AFTER 10 SECONDS.

SECONDARY ACTIONS (FLIGHT DECK)

APU Control Switch - OFF. Fuel valve indicator CLOSED, start indicator "black".

Air Delivery Valve - CLOSE.

Air Crossfeed Valve - CLOSE. Indicator SHUT.

If APU fire continues:

Initiate Ground Evacuation procedure, if required.

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SMOKE FROM AIR CONDITIONING SYSTEM

Oxygen Masks - ON. Regulators 100% and emergency levers ON, if required.

Cockpit Speakers - ON, or headsets, if desired.

Interphone Microphone Selector - NORM INT or EMERG INT.

Goggles - ON.

Air Crossfeed Valve - CHECK CLOSED.

No. 1 MAC Valve - CLOSE. This allows, by process of elimination, the determination of which refrigeration pack or engine is the problem.

No. 1 Engine Instruments - CHECK. Attempt to pick out any oil system problem, etc., that may be causing smoke to enter cabin.

If smoke persists:

No. 1 MAC Valve - OPEN. Re-establish incoming air for pressurized flight so No. 2 MAC valve can be shut down.

No. 2 MAC Valve - CLOSE. This will allow a check of No. 2 system to determine if it was the cause.

If smoke mainly from cabin outlets:

No. 2 MAC Valve - CLOSE.

If smoke is coming from ventilation grill in aft flight deck roof:

No. 1 MAC Valve - CLOSE.

If smoke is coming from only cockpit eyeballs:

No. 2 MAC Valve - CLOSE.

If smoke stops:

Leave pack deactivated. If reinstatement of a deactivated pack is needed for comfort, attempt may be made to determine specific fault as follows:

Isolation Valve (for deactivated pack) - CLOSE.

Air Crossfeed Valve - OPEN.

Master Valve (for deactivated pack) - OPEN.

If smoke reappears:

Master Valve - CLOSE IMMEDIATELY. Leave master valve CLOSED for remainder of flight.

Air Crossfeed Valve - CLOSE.

Isolation Valve - OPEN.

If smoke still persists:

Follow SMOKE EVACUATION and/or EMERGENCY DESCENT procedures in this chapter if severity of condition warrants.

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SMOKE EVACUATION - AIRCRAFT PRESSURIZED

Oxygen Masks - ON. Regulators 100% and emergency levers ON, if required.

Cockpit Speakers - ON, or headsets, if desired.

Interphone Microphone Selector - NORM INT or EMER INT.

Goggles - ON.

Isolation Valves and Master Valves - OPEN. It is desirable, for maximum ventilation, to operate both packs.

Cabin Altitude Selector - INCREASE AS REQUIRED.

Cabin Rate Control - INCREASE AS REQUIRED.

NOTE: Normal airflow from the cabin pressurization system should be adequate to remove smoke originating from sources other than the air conditioning/pressurization system itself. However, if ventilating system airflow is significantly reduced (i.e., smoke was coming from ventilation system), it may be necessary to descend and/or depressurize to assure proper smoke removal.

If this procedure is accomplished after initiating the Electrical Fire or Smoke procedure, it will be necessary to use air dump valve to control cabin pressurization.

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SMOKE EVACUATION - AIRCRAFT UNPRESSURIZED

Oxygen Masks - ON. Regulators 100% and emergency levers ON, if required.

Cockpit Speakers - ON, or headsets, if desired.

Interphone Microphone Selector - NORM INT or EMER INT.

Goggles - ON.

Both MAC Valves - CLOSE. This will isolate cabin from all incoming air from any source.

Ram Air Valve - OPEN. This switch will only operate when aircraft is unpressurized. It will open ram air inlet in No. 2 refrigeration inlet duct on right side (belly) of aircraft.

Discharge Valve - CHECK OPEN. Check discharge valve position indicator on First Officer's right console.

Safety Valve - OPEN. This valve will only operate when cabin differential pressure is less than 1 PSI.

If discharge valve not fully open:

Air Dump Valve - OPEN. Press air dump valve control knob and rotate fully clockwise to full OPEN. Located on First Officer's side console.

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SMOKE OR FIRE PROCEDURES (Not on Checklist)

GENERAL

Apart from local fires or smouldering caused by, for instance, carelessness with matches or cigarette ends, there are three foreseeable sources of smoke or fire in the fuselage. They are the electrical system, the air conditioning system, and the freight holds.

Unless the safety of the aircraft would otherwise be endangered, it is recommended that until the facts are established, the aircraft altitude, attitude, and course should be maintained, preferably with the autopilot engaged. After a diagnosis has been made, carry out the procedure under the appropriate heading.

If smoke or fire becomes a serious problem, make an emergency descent and land as soon as practicable.

DIAGNOSIS

Correct diagnosis is more important than overhasty action. At the first sign or smell of smoke:

- Check the flight deck.
- Carefully smell the incoming air at the nearest flight deck air inlet.
- Look down the passenger cabin.

ELECTRICAL

An electrical fire should be distinguishable by smell; in fact, the smell is more likely to be noticed before the smoke. If electrical smoke is confirmed and traced to a particular circuit, isolate that circuit.

AIR CONDITIONING

Smoke from all inlets (flight deck and passenger cabin conditioned and cold air) indicates that smoke is entering through No. 1 (left) system, or possibly both systems if the air crossfeed valve is open.

Smoke from the flight deck cold air louvers and all passenger cabin inlets indicates that smoke is entering through No. 2 (right) system.

FREIGHT HOLDS

In general, the protective sealing material of a hold is capable of smothering a fire. As the airflow under the cabin floor moves forward past the freight holds and out through the discharge valve, there is unlikely to be much smell; but an unusually high cabin temperature and warm cabin floor could signify a freight hold or underfloor fire.

Isolate the electrical supply to all service lighting (underfloor, gear bays, and tailcone) by tripping the service circuit breaker on panel B behind the Captain's seat.

Service C/B #122 (Panel B-3) - TRIP.

INS Cooling Blower Lights - EXTINGUISHED.

NOTE: Consider long range fuel system, if installed.

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RAPID OR EXPLOSIVE DECOMPRESSION

RAPID DECOMPRESSION

If pressure loss is due to a known structural failure, such as window blowout, the need to check items controlling an inflow or outflow is obviated; instead, follow EXPLOSIVE DECOMPRESSION procedure immediately.

Air Inflow/Air Outflow - CHECK.

- Master Valve and System Fail Lights - EXTINGUISHED.
- Both Master Valves and Both Isolation Valves - OPEN.
- Ram Air and Safety Valves - CLOSED.
- Discharge (Outflow) Valve Position Indicator - CHECK.

If loss of pressure can be promptly arrested (i.e., cause is obvious and corrective action is successful) descent is not necessary.

IF NOT ARRESTED BY 10,000 FEET CABIN ALTITUDE, FOLLOW EXPLOSIVE DECOMPRESSION PROCEDURE.

EXPLOSIVE DECOMPRESSION

If autopilot is engaged at the time of decompression, leave it engaged until ready for descent.

Oxygen Masks - ON. Regulators 100% and emergency levers ON, if required.

Cockpit Speakers - ON, or headsets, if desired.

Interphone Microphone Selector - NORM INT or EMER INT.

Throttles - CLOSED.

Speed Brake Handle - 20°.

No Smoking/Seat Belt Switches - ON.

Descend - STRAIGHT AHEAD OR BANK 30° (MAXIMUM).

Passenger Oxygen Red Knob - PULL.

Transponder - CODE 7700.

F/O Oxygen Mask Mike Switch - PA. The First Officer will make a PA announcement, "Ladies and gentlemen pull down and use your oxygen masks. No smoking please."

When structural damage is suspected, avoid high IAS and abrupt maneuvering and complete the following:

Both Master Valves - CLOSED.

Air Dump Valve - OPEN.

Ram Air Valve - OPEN.

When cabin altitude sufficiently low:

Oxygen Regulators - NORMAL. Reset red and green knobs on passenger oxygen panel.

If passenger oxygen masks are dropped, but pressurization is subsequently restored, flight may be continued if sufficient oxygen pressure remains. Reset red knob on passenger oxygen panel.

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EMERGENCY DESCENT

The following procedure assumes structural integrity of the airplane. If structural damage has occurred or is suspected, reduce airspeed and rate of descent as deemed necessary and avoid abrupt maneuvering.

Throttles - CLOSE.

Speed Brake Handle - 20°.

No Smoking/Seat Belt Switches - ON.

Transponder - CODE 7700.

Descend - STRAIGHT AHEAD OR BANK 30° (MAXIMUM).

Target Speed - Mmo or Vmo, whichever occurs first. With Mach trim inoperative, emergency descent speed must be limited to Mach .72 or Vmo, whichever occurs first.

Make altitude awareness callouts. Passing each 5,000 feet, callout altimeter setting and 1,000 feet above desired level-off altitude.

If emergency descent is necessitated by loss of cabin pressure, follow RAPID OR EXPLOSIVE DECOMPRESSION procedure in this chapter.

Start decreasing rate of descent by "easing off" the speedbrakes steadily and smoothly about 1,000 feet above the desired level-off altitude. This will prevent overshooting the desired altitude.

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CABIN ALTITUDE WARNING (Not on Checklist)

If the cabin altitude warning appears, check the cabin pressure indicator. If it confirms the warning, the flight crew must immediately don oxygen masks and if the situation elevaluation requires it, make an emergency descent.

Should cabin pressure be normal, a false warning should be suspected, but the indicator must be monitored for the remainder of the flight.

The cabin altitude warning light should illuminate and the horn will sound at approximately 10,000 feet cabin altitude.

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MULTIPLE GENERATOR FAILURE

Loss of output of one generator and/or loss of one bus is not considered an emergency. Malfunctions of individual generating components are covered in Chapter 7 - ELECTRICAL of this manual. In the event of loss of both engine-driven generators and/or both normal AC buses, proceed as follows:

Either Generator - RESET.

If unable to reset:

APU - START AND USE ITS GENERATOR.

Two fully charged batteries should provided power for essential loads for about 45 minutes. Obviously, those system requiring transient loads i.e., APU starting, should be used only as necessary to conserve battery power. System no considered essential to flight under existing conditions, i.e., essential light if daytime flight, should also be deactivated to further conserve battery power.

With the generator inoperative, only services provided by the battery bus, ESS DC bus, and ESS AC bus will be available. These services are as follows:

NOTE: This list covers only basic systems and functions. Certain other functions and specific warning lights, not covered here, also remain inoperative.

From Battery Bus

- Engine Fire Protection (Shot #2)
- APU Fire Protection
- APU Start Motor
- DC Hydraulic Pump
- DC Voltmeter

From ESS AC Bus

- Captain's HDI
- Captain's Altimeter
- Captain's RMDI
- Engine and APU Fire Detection
- Fuel Quantity Indicators
- Vibration Indicators
- Flap Position Indicator

From ESS DC Bus

- Captain's VHF COMM & VHF NAV
- Captain Glideslope
- Ess. Cockpit Lights (Compass, Console, Fwd Panel Flood, Ovhd. Panel)
- Navigation Lights
- Master Warning System
- Engine and APU Fire Waring
- Engine Fire Protection (Shot #1)
- Engine Ignition (High Energy)
- Left (Captain's) Pitot Heat
- No. 1 Stall Warning System (No lights for A & B valves, no low pressure light, no vane heaters)
- APU Control and Indication
- Fuel System Control and Indication (cannot turn off engine pumps)
- Left Pneumatic System and Left Pack (No auto pressure control and no temperature control)
- Standby Horizon
- Air Crossfeed Valve Closes

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Can smoke source be located?

NO

Prepare for loss of all but ESS AC and ESS DC buses.
Oxygen Masks, Speakers, Interphone, Goggles -- AS REQUIRED
Booster Pumps ---------- ON
Fuel Crossfeed ------- CLOSED & INDICATOR CHECKED
Normal & Emergency Lights -- ON
Pressurization --------- MANUAL
AC & DC Splits (#353,#361)-TRIP
Ins-Att Switches ---------- OFF
Flight Altitude ------ CONSIDER LOWER ALTITUDE

YES

Remove electrical power from faulty equipment or bus.

APU Gen.(if running) ----- TRIP
No. 1 AC Generator ------- TRIP

Are Captain's Instruments normal?

YES

HDI Selector ------ F/O ON ALT
No. 2 AC Generator ------ TRIP

NO

F/O's Flt. Instruments -- CHECK
HDI Selector ------ CAPT ON ALT
Battery Switch ---------- OFF

For reinstatement procedure, refer to ELECTRICAL SYSTEM FIRE OR SMOKE REINSTATEMENT II in Abnormal Procedure section 1-305.

Did smoke stop?

NO

No. 2 AC Generator ------ RESET
F/O Flt. Instruments ---- CHECK
HDI Selector ------ CAPT ON ALT
Battery Switch ---------- OFF

For reinstatement procedure, refer to ELECTRICAL SYSTEM FIRE OR SMOKE REINSTATEMENT II in Abnormal Procedure section 1-305.

YES

Continue on battery power.

NOTE: A fully charged battery will provide power in this configuration for approximately 45 minutes.

For reinstatement procedure, refer to ELECTRICAL SYSTEM FIRE OR SMOKE REINSTATEMENT I in Abnormal Procedure section 1-305. Reinstatement should be initiated before battery voltage drops below 18 volts.

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OVERWEIGHT LANDINGS

An overweight landing in lieu of dumping fuel can be made at weights up to a maximum specified weight as outlined on the following pages in this section and under the conditions set forth in Chapter 4 - PLANNING & PERFORMANCE.

On all BAC 1-11 400 series airplanes, all overweight approaches and landings will be made with cabin air conditioning bleeds OFF (MAC valves to OFF or APU). The maximum allowable overweight landing is 82,000 lbs., unless further limited by the tabulated data on the following pages in this section.

Should the decision be made to land overweight, compute the allowable overweight landing limit as follows:

Example No. 1:

- Flaps - 26°, preferred by flight crew.
- Airport Elevation - 3,000 feet.
- OAT - 90°F/32°C.
- Available Runway Length - 8,000 feet.
- Runway Conditions - DRY, wind CALM.

Determine Maximum Overweight Landing Limit for Altitude and Temperature (Approach Climb Limit) for 26° Flaps, No Bleeds using appropriate chart in this section.

Airport Elevation 3,000 feet and OAT 90°F = 81,500 lbs.

Determine Required Runway for Landing at 81,500 lbs. from Required Landing Runway chart for 26° Flaps, No bleeds, 0 Wind, 0 Slope in this section.

Airport Elevation 3,000 feet and 81,500 lbs. = 6,700 feet.

NOTE: The maximum temperature for this condition is approximately 89.5°F/32°C below the approach climb limit.

The runway available for landing is 8,000 feet long and DRY. If the condition of the runway had been WET, the required runway for landing would be only 7,705 feet, still less than the available.

The reference speed (Vref) for a 26° flap landing at 81,500 lbs. is 139 knots.

Example No. 2:

- Airport Elevation - SEA LEVEL.
- OAT - 70°F/21°C.
- Available Runway Length - 6,000 feet.
- Runway Conditions - DRY, wind CALM.
- Flap Setting - May be limited due to runway length available for landing.

Determine Maximum Overweight Landing Limit for Altitude and Temperature (Approach Climb Limit) using appropriate chart for 26° Flaps/45° Flaps in this section.

- 26° Flaps - No Bleeds = 82,000 lbs.
- 45° Flaps - No Bleeds = 82,000 lbs.

(cont'd.)

OVERWEIGHT LANDINGS
(cont'd.)

Example No. 2: (cont'd.)

Determine Maximum Overweight Landing Limit Allowable for Runway Length available (6,000 feet DRY) from Required Landing Runway charts for 26° Flaps/45° Flaps, No Bleeds, 0 Wind, and 0 Slope in this section.

- 26° Flaps, No Bleeds = 79,000 lbs.
  Max. Temp = 47.5°C/118°F
- 45° Flaps, No Bleeds - 82,000 lbs.
  Max. Temp = 36.5°C/97°F

The Maximum Overweight Landing Limit Allowable with the Available Landing Runway Length is 82,000 lbs. using 45° flaps and no bleeds. This weight is good to a maximum OAT of 97°F/36.5°C.

The reference speed (Vref) for a 45° flap landing at 82,000 lbs. is 131 knots.

NOTE: For approaches with engine anti-icing ON, refer to appropriate correction chart in Chapter 4 - PLANNING & PERFORMANCE.

For landings with winds other than calm, if additional landing runway length is required, refer to the appropriate graph for 45° or 26° flap landings in Chapter 4 - PLANNING & PERFORMANCE.

After Computing Maximum Overweight Landing Weight

- Dump excess fuel to reduce airplane landing weight as required. Refer to Abnormal Procedure section 1-309 for Fuel Jettisoning.
- There are no structural wing and center fuel quantity limits for landings at weights of 82,000 lbs. or less. Fuel in long range tanks (if installed) can be included into the zero fuel weight center of gravity.
- Use standard approach and landing techniques.
- Be alert for landing gear wheel brake fires. Monitor wheel brake temperatures.
- Release the brakes after parking and wheels are chocked. This will assist in cooling the brakes. Do not approach hot brakes.
- Record all overweight landings and the procedures followed in the aircraft log book.

OVERWEIGHT LANDINGS (cont'd.)

MAXIMUM OVERWEIGHT LANDING FOR ALTITUDE AND TEMPERATURE

26° FLAPS - NO BLEEDS

	-18°C 0°F	-07°C 20°F	+05°C 40°F	15°C 60°F	21°C 70°F	27°C 80°F	32°C 90°F	38°C 100°F	44°C 110°F
S.L.	82.0	→	→	→	→	→	→	82.0	81.8
500'	82.0	→	→	→	→	→	→	82.0	80.4
1000'	82.0	→	→	→	→	→	→	82.0	79.0
1500'	82.0	→	→	→	→	→	→	82.0	77.7
2000'	82.0	→	→	→	→	→	82.0	80.4	76.0
3000'	82.0	→	→	→	→	82.0	81.5	77.4	
4000'	82.0	→	→	→	82.0	81.5	78.4	74.5	
5000'	82.0	→	→	82.0	81.7	78.5	75.4		
6000'	82.0	→	82.0	81.6	78.7	75.5			
7000'	82.0	→	82.0	78.5	75.7				

45° FLAPS - NO BLEEDS

	-18°C 0°F	-07°C 20°F	+05°C 40°F	15°C 60°F	21°C 70°F	27°C 80°F	32°C 90°F	38°C 100°F	44°C 110°F
S.L.	82.0	→	→	→	→	→	82.0	80.0	75.6
500'	82.0	→	→	→	→	→	82.0	78.5	74.2
1000'	82.0	→	→	→	→	82.0	81.4	77.0	
1500'	82.0	→	→	→	→	82.0	79.7	75.5	
2000'	82.0	→	→	→	82.0	81.5	78.0		
3000'	82.0	→	→	82.0	81.6	78.4	75.0		
4000'	82.0	→	82.0	81.5	78.5	75.4			
5000'	82.0	82.0	81.4	78.3	75.5				
6000'	82.0	81.0	78.5	75.2					
7000'	80.5	78.2	75.5						

OVERWEIGHT LANDINGS (cont'd.)

MAXIMUM OVERWEIGHT LANDING LIMIT FOR AVAILABLE RUNWAY AND ALTITUDE AND TEMPERATURE

NOTE: Check Maximum Overweight Landing Limit Weight charts for Altitude and Temperature in this section.

REQUIRED LANDING RUNWAY - 26° FLAPS (NO BLEEDS - 0 WIND - 0 SLOPE)

	79,000#		80,000#		81,000#		82,000#	
	DRY	°F	DRY	°F	DRY	°F	DRY	°F
	WET	°C	WET	°C	WET	°C	WET	°C
	6000	118	6100	116	6200	113	6300	111
S.L.	6900	47.5	7020	46.5	7130	45	7250	44
	6100	111	6250	108	6350	106	6400	104
1000'	7020	44	7190	42.5	7300	41	7360	40
	6300	104	6400	102	6500	98	6550	96
2000'	7250	40	7360	38.5	7480	37	7530	35.5
	6450	96	6550	93	6650	91	6750	88
3000'	7420	36	7530	34	7650	33	7760	31
	6600	88	6700	85	6800	82	6900	79
4000'	7590	31	7710	29.5	7820	28	7940	26
	6800	79	6900	75	7000	72	7100	70
5000'	7820	26	7940	24	8050	22.5	8170	21
	6950	68	7050	64	7150	61	7300	57
6000'	7990	20	8110	18	8220	16	8400	14
	7150	57	7250	51	7350	48	7500	43
7000'	8220	14	8340	11	8450	09	8630	06
Vref	136		137		138		139	

REQUIRED LANDING RUNWAY - 45° FLAPS (NO BLEEDS - 0 WIND - 0 SLOPE)

	79,000#		80,000#		81,000#		82,000#	
	DRY	°F	DRY	°F	DRY	°F	DRY	°F
	WET	°C	WET	°C	WET	°C	WET	°C
	5250	102	5350	100	5400	98	5500	97
S.L.	6040	29.5	6150	38	6210	37	6325	36.5
	5400	95	5450	93	5550	90	5600	88
1000'	6210	35	6270	34	6380	32.5	6440	31
	5500	88	5600	82	5700	81	5750	79
2000'	6320	30.5	6440	29	6560	27.5	6610	26
	5650	79	5750	75	5850	71	5900	70
3000'	6500	26	6610	24	6730	22	6790	21.5
	5800	68	5900	64	6000	61	6050	57
4000'	6670	20	6790	18	6900	16	6960	14
	5950	55	6050	51	6150	45	6200	38
5000'	6850	13	6960	10.5	7070	07	7130	03
	6100	37	6200	28	6300	19	6350	12
6000'	7020	03	7130	-02	7250	-07	7300	-11
	6250	12	6350	03	6450	0	Too	High
7000'	7190	-11	7300	-16	7420	-18	Too	High
Vref	128		129		130		131	

LANDING UNDER EMERGENCY CONDITIONS (Not on Checklist)

LANDING WITH EMERGENCY ELEVATOR POWER

NOTE: Refer to LANDING WITH HYDRAULIC FAILURE - BOTH SYSTEMS INOP abnormal procedure, Section 1-310 of this manual for procedures involving other hydraulically powered flight controls and systems that could possibly be inoperative in the event of a landing using emergency elevator power.

In the event of a complete main hydraulic system failure or both control cutoff levers are in the OFF position, elevator control will revert to manual. If this reversion to manual elevator occurs at speeds at or near Vmo/Mmo, there will be a noticeable nose-up pitch tendency. The aircraft should be brought back into trim by reducing speed. Once accomplished, maintain in-trim speed as long as practicable.

Once traffic pattern maneuvering speeds have been attained and the wing flaps positioned to 18°, any nose-down tendency should be corrected by using the electric trim tab before emergency elevator power is selected to ON. Any further out-of-trim forces after engagement of the Emergency elevator must be held on the control column.

Particularly at aft CG, elevator stick forces are lighter than normal with emergency elevator power. For large elevator deflections, the stick forces increase steeply if a main feel unit is still pressurized.

The maximum airspeed for selecting emergency elevator to EMERGENCY is 270 KIAS or .73M.

The wing flaps must be lowered by setting the normal flap selector to 18°, then selecting the DC hydraulic pump switch to EMERGENCY FLAP. It takes approximately 4 minutes to obtain an 18° flap setting. With flaps at 18°, the final approach speed should be checked. Speed should be slowly reduced on nearing the runway so as to cross the runway threshold at Vref speed.

Rudder power is very limited and the aircraft has a tendency to slip in turns. Crosswinds with components greater than 10 knots should be avoided during landing.

Before selecting reverse thrust after touchdown, the column must be held forward to counteract the nose-up trim change as reverse thrust is applied. This is particularly important at aft CG conditions.

NOTE: Deactivate GPWS before landing with wing flaps less than 26° (FLAP OVERRIDE) or with landing gear handle unable to be selected DOWN (INHIBIT).

LANDING UNDER EMERGENCY CONDITIONS (Not on Checklist) (cont'd.)

LANDING WITH MANUAL ELEVATOR CONTROL

In the unlikely event that emergency elevator power should fail and the fail light illuminates, immediately place emergency elevator switch to OFF.

Prior to starting approach, if passenger load permits, reseat passengers, so as to reduce the stick forces required to maintain airplane attitude.

Landing procedure is the same as landing with emergency elevator power, however, with manual control the elevators are very heavy and there is little self-centering. Use elevator emergency trim tab to relieve sustained stick forces during approach, but use care not to overcorrect.

Elevator forces to flare are heavy, but the actual attitude change from the approach to touchdown is small and only a very small flare is required to land the aircraft.

EMERGENCY FLAP EXTENSION

If both normal hydraulic systems are inoperative, flaps may be extended only to 18° for approach and landing as follows:

- Slow to 200 KIAS maximum, but no slower than 0° Flap maneuver speed.

- Place flap lever to 18°.

- Place DC hydraulic pump switch in EMERG FLAPS position. Flaps should move from 0° to 18° in about 4 minutes.

- When flaps reach 18°, return DC pump switch to OFF.

  NOTE: If brake accumulators require "topping off" and DC pump is to be used for flap extension, top off accumulators after extending flaps (as return fluid from flaps will then be available for accumulators).

- Select GPWS to FLAP OVERRIDE.

FINAL APPROACH SPEEDS FOR LANDING WITH ABNORMAL FLAP SETTINGS

The following table presents final approach ("Reference") speeds for landing with abnormal flap settings. Set airspeed bugs to value obtained from table, use this setting as "Reference", adjusting speed as necessary for existing conditions. (Table speeds are 1.3 Vs for specified flap setting.)

GROSS WEIGHT	FLAP SETTING 0°	3°	8°	18°	26°	
60,000	149	140	134	126	120	
65,000	155	146	139	131	124	
70,000	160	151	144	136	129	
75,000	166	156	149	140	133	
78,000	169	159	152	143	136	--MAX. LANDING WEIGHT
80,000	171	161	154	145	137	
85,000	176	166	158	149	141	

LANDING UNDER EMERGENCY CONDITIONS (Not on Checklist) (cont'd.)

EMERGENCY LANDING GEAR EXTENSION

Landing gear may be extended by free fall with landing gear handle in either UP or DOWN position; however, whenever possible (handle not jammed, etc.) handle should be placed in DOWN position before extension. Extend gear as follows:

- Place gear handle to DOWN.
- Observe gear speed limit of 230 knots.
- Raise and latch gear emergency extension handle next to F/O's seat. GEAR UNSAFE light will illuminate almost immediately and will remain illuminated since main gear doors remain open. Green light for each gear should illuminate when gear reaches DOWN and LOCKED position.
- Visually check main gear mechanical position indicator on each wing through cabin windows and nose gear mechanical position indicator through periscope in cockpit floor. Turn on wheel well lights. Main gear is safe for landing if 1/2-inch or more of green shows above wing top. Nose gear is safe for landing if at least 75% of lighted GREEN circle is visible.
- Do not exceed 230 KIAS following gear extension, main gear door remains open.
- Place standby steering switch to ON during final approach.

If a visual check of any landing gear mechanical position indicator does not give a positive gear DOWN and LOCKED indication, take appropriate emergency measures against the possibility of gear collapse on touchdown or rollout. Refer to PARTIAL OR GEAR UP LANDING procedures in this chapter.

After landing, pin all landing gear before taxi. Pins are located in forward cargo compartment.

When landing is made with main gear doors open, lower edge of doors will scrape on runway. Normally, this causes damage only to rub strip on each door. On training flights, do not land with doors open following emergency extension demonstration.

Following an actual emergency extension, do not lower emergency extension handle, even after landing. However for training etc., handle may be lowered in flight to reset system.

If No. 1 hydraulic system pressure NOT NORMAL, LIMITED STEERING WILL BE AVAILABLE FROM STANDBY STEERING ACCUMULATOR. Place standby steering switch to ON during final approach. Accumulator should be adequate for normal landing and runway turnoff, but will not provide for extended taxiing. Steer with brakes, if necessary. Amber light illuminated indicates low pressure in nose steering accumulator.

If No. 1 hydraulic system pressure is NORMAL, as in the case of an emergency gear extension due to the landing gear control handle being stuck in the UP position, unlimited nosewheel steering will be available with the standby steering switch ON. No. 1 hydraulic system will continually charge standby steering accumulator.

(cont'd.)

LANDING UNDER EMERGENCY CONDITIONS (Not on Checklist) (cont'd.)

EMERGENCY LANDING GEAR EXTENSION (cont'd.)

With no No. 1 hydraulic system pressure, system inoperative or free fall lever pulled, rudder fine steering is NOT DEPENDABLE. Pressure to connect the rudder pedals to the nosewheel steering cables is not available.

If landing gear handle cannot be placed in DOWN Position, select GPWS to INHIBIT.

Anti-skid will be INOPERATIVE. Differential footbrakes are available, but with no anti-skid protection. Avoid excessive braking that could cause tire damage.

Increase required landing distance by 40%.

Normal cockpit landing gear safe indication after an emergency landing gear extension is three (3) GREEN DOWN & LOCKED LIGHTS and the GEAR UNSAFE LIGHT ILLUMINATED. The doors remaining OPEN will cause the GEAR UNSAFE LIGHT to remain ILLUMINATED.

PARTIAL OR GEAR UP LANDING (Not on Checklist)

GENERAL

It is recommended that aircraft with partially failed landing gear should be landed with as many of the serviceable gear extended as possible, since experience and research into the problem has shown that this procedure results in less damage to the aircraft, and a greater degree of safety to the passengers, than a belly landing. Furthermore, it is recommended that such a landing should be made on a hard surface in preference to grass or sand.

NOTE: Deactivate GPWS before landing with flaps less than 26° (FLAP OVERRIDE) or with gear handle unable to be selected down (INHIBIT).

However, the Captain has the discretion to make a belly landing should s/he consider this desirable. Steep snow banks or other obstacles at the side of the runway, a narrow landing strip where any swing may lead to more serious consequences, or marginal weather conditions, must all be taken into account.

In the procedures which follow, the assumption is made that either:

- The affected gear is locked up or that it is partly down or trailing, thus not indicating down, and that it will collapse during the landing roll.

- If the Captain is in any doubt that the landing gear is locked down, he must act in accordance with these assumptions.

- If after coming to rest, the affected gear has not collapsed, do not attempt to move the aircraft until the downlocks have been checked or ground locks inserted.

NOSE GEAR UP

- Set stabilizer for normal, in-trim approach.

- Make a normal touchdown with nose held at normal flare attitude.

- Use full speedbrakes as during normal landing.

- Use reverse thrust as required throughout landing roll. Use of reverse aids in holding nose off.

- Use minimum possible braking. Braking induces a nose-down force.

- At about 85 knots, slowly lower nose to surface. Actually, loss of pitch control does not occur until about 70 knots, depending on gross weight and CG; however, use of 85 knots assures good elevator control throughout manuever.

- Retract speedbrakes before airplane stops.

- Secure cockpit at termination of rollout.

PARTIAL OR GEAR UP LANDING (Not on Checklist)

ONE MAIN GEAR UP

- Use normal approach and landing speeds. Land the airplane on the side of the runway that corresponds to the available main gear down. For example, with left main gear down, land on left side of runway. Raise the speedbrake lever normally. Keep wings level. Lower nose wheel to runway early in landing roll.

- Keep unsupported wing up as long as possible using lateral control. Complete loss of lateral control will occur at about 50 knots.

- Use rudder and nosewheel steering if available, to keep airplane rolling straight, with as much braking as can be tolerated on "good" side.

- When wing on unsupported side makes contact with surface, apply heavy braking on "good" side to maintain directional control.

- Use of reverse thrust is not recommended.

- Secure cockpit at termination of rollout.

NOSE GEAR ONLY DOWN

- Initial contact should be made on aft body structure; then, allow nose gear to contact runway. If nose gear touches first, porpoising may occur.

- Normal speedbrakes after touchdown.

- Immediately after touchdown, pull fire handles, place start levers to SHUT, and turn OFF all fuel boost pumps.

- Secure cockpit at termination of rollout.

BELLY LANDING

- Land on runway using full flaps.

- Use normal approach and landing speeds. Anticipate that the airplane may float further than normal before touchdown.

- Speedbrakes should not be applied.

- Immediately after touchdown, pull fire handles, place start levers to SHUT, and turn OFF all fuel boost pumps.

- Secure cockpit at termination of rollout.

PARTIAL OR GEAR UP LANDING (Not on Checklist)
(cont'd.)

RUNWAY FOAMING

- When the aircraft must be landed with one main gear retracted, the use of foam is recommended. The foam should be spread on the side of the runway corresponding to the gear up side to enable better braking and nosewheel steering with the operable gear.

- The use of foam for gear up landings is a Captain's judgment item depending on temperature (above 32°F), availability of fire fighting equipment, etc. The use of foam can greatly increase repair costs because of corrosion.

- Ideal situation is to touchdown the aircraft structure, other than landing gear, in foam, and remain in foam until stopped.

- Principal function of foam is to suppress large magnitude type sparks that could cause ignition of fuel spray.

- Best time to land is within 15 minutes of foaming. (Good up to one hour.)

- Foaming decreases friction value of runway only 3%. (Same as wet runway.)

- After foaming, allow time for foam trucks to refill before landing.

- The fire department should foam the runway to allow airplane structure, other than landing gear, to touchdown and remain in the foam.

ADDITIONAL "G" LOADS TO INSURE LANDING GEAR DOWN & LOCKED

"G" loads imposed on an aircraft in an effort to insure that the landing gear is locked down when a landing gear malfunction occurs could result in injury to passengers or crewmembers.

In order to establish safeguards to prevent possible injury to passengers and crewmembers alike, when additional "G" loads on an aircraft are necessary, the following is necessary:

- Before such maneuvers are executed, pilots are to insure that passengers and flight attendants are in their seats and seat belts are fastened. Whenever possible, flight attendants should be given ample time to check passenger seat belts before taking their own seats and fastening belts.

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DITCHING (Not on Checklist)

SEND DISTRESS SIGNALS

On Captain's command, First Officer will transmit mayday, establish position, course, speed, altitude, situation, intention, time and position of intended touchdown, type of aircraft, and request ASR intercept using prevailing air to ground frequency. The F/O will set transponder code 7700 and, if practical, advise Captain of course to nearest ship or landfall.

ADVISE CREW AND PASSENGERS

Alert crew and passengers to prepare for ditching, seating passengers as far forward as possible. Assign life raft positions and order all loose equipment in aircraft secured.

FUEL BURN-OFF

Consider burning off fuel prior to ditching, if emergency permits, retaining enough to enable power to be used throughout the approach. This will provide greater buoyancy. Normally, empty center tank and long range tanks, if installed.

ACCOMPLISH APPROPRIATE DESCENT/APPROACH CHECKLIST

Use NORMAL or EMERGENCY/ABNORMAL checklist applicable to aircraft configuration. Particular care should be used in selecting proper flap setting for emergency/abnormal configuration.

BELOW 5,000 FEET

No Smoking/Seat Belt Sign - ON.

Pressurization Controls - DEPRESSURIZE. If time is essential, place both MAC valves to APU position, both isolation valves to CLOSE, take control of dump valve and open fully, place safety valve to OPEN, and ram air valve to RAM. If time is not essential, climb cabin to aircraft altitude at a selected rate, then place switches in above positions.

NOTE: After aircraft is depressurized, close air dump valve if ditching.

Vests, Shoulder Harnesses and Seat Belts - ON. Put on life vest, shoulder harness, and seat belt and adjust for snug, comfortable fit. Do not inflate life vest until after exit from airplane.

(cont'd.)

DITCHING (Not on Checklist)
(cont'd.)

BELOW 5,000 FEET (cont'd.)

Passenger Cabin Preparation - COMPLETE. First Officer will confer with cabin personnel either by interphone or by personal report to cockpit to assure that passenger cabin preparations for ditching are complete. Preparation should include stowing of loose articles in lavatories or other suitable locations. Passengers should have donned life vests and been cautioned not to inflate them prior to evacuation from the airplane. Passengers should have loosened neckwear and collars, removed shoes and eyeglasses, adjusted seat back upright and seat belts secured snugly. Blankets and pillows should have been distributed with instructions to place them in front of the face prior to impact. All available food, fluids, flashlights, first aid kits and other emergency equipment should be ready for evacuation.

Radio - TRANSMIT FINAL POSITION. Transmit all pertinent information pertaining to: final ditching position, weather and sea conditions, rescue instruction and information if ship or other available rescue unit is standing by, and any other instructions or information which may be required.

Emergency Exit Lights - ON. Place ON to assure lighting and direction for passengers when aircraft electrical power is terminated. This action will assure that the battery pack-powered emergency lights come on to assist in evacuating the airplane. It may also serve as a signal to the Flight Attendants to prepare the passengers for impact, if prearranged.

DITCHING FINAL

Landing Gear - UP. The landing gear should be retracted to present a smooth, unobstructed fuselage surface for minimum drag upon contacting the water. With the gear extended, the protruding gear and open wheel wells would cause violent deceleration and the possibility of nosing under. If landing with the gear handle not down, select INHIBIT to deactivate the GPWS.

Flaps - GENERALLY 45°. It is desirable to touchdown at the lowest possible speed; therefore, use of 45° flap extension is recommended. If landing with flaps less than 26°, select FLAP OVERRIDE to deactivate the GPWS.

Speed Brakes - RETRACTED.

Emergency Signal - 6 CHIMES. Advises cabin crew of imminent touchdown. At 500 feet, give six chimes and turn on the emergency exit lights. This provides signal to Flight Attendants and passengers to assume the brace position.

(cont'd.)

DITCHING (Not on Checklist)
(cont'd.)

DITCHING FINAL (cont'd.)

The final approach should be made at a shallow angle, at normal speed, using flaps fully extended. The rate of descent should be kept to a minimum and the aircraft rotated slightly less than for a normal landing. No attempt should be made to stall on at a greater angle as this results in a severe impact with violent nose-down pitch.

The aircraft should be ditched along the swell, or if the swell is negligible, into the wind.

After Impact Procedure - REVIEW.

Fire Control Handles - PULL. During ditching, pull handles prior to leaving the cockpit, if time permits. This action will shut off fuel and hydraulic oil at the engines. If the situation indicates a need, the fire handles can be rotated to discharge the extinguishing agent into the engine nacelles.

If the battery switch is off, only shot two can be used to discharge the fire extinguishing agent.

INITIATE EVACUATION

After the airplane has come to rest, proceed to assigned ditching stations, launch flotation devices, and evacuate as soon as possible. The airplane may remain afloat indefinitely if fuel load is minimal and no serious damage was sustained during landing.

Evacuate all passengers through emergency exit windows over wings. The forward cabin doors may also be used if they are above the water line.

Have passengers climb out and hang onto wings, cabin, or any flotable item.

Throw seat cushions and any flotable objects (such as empty suitcases) out to passengers on wings and in water for use as life preservers.

Disconnect escape slides from exit doors (use care not to inflate slide inside aircraft). Inflate them over front of wing edges and use as life raft. Be careful not to rip or puncture slides.

Have passengers form a hand-holding circle in the water and use any buoyant object to help stay afloat if the aircraft sinks.

Avoid drifting or blowing into or under parts of the airplane.

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EMERGENCY LANDING & PASSENGER EVACUATION (Not on Checklist)

GENERAL

Aircraft emergencies and emergency landings are never the same. No one set of procedures can be written to cover all emergencies.

If you know your procedures and apply them with intelligent thought, quick action, and in a calm authoritative manner, chances for survival for all people on board are greatly increased.

CHAIN OF COMMAND

Captain
First Officer
Flight Attendant(s)

EMERGENCY TYPES

Planned - Captain tells crew the nature of the emergency and what s/he wants done.

Unplanned - Happens during taxi, takeoff, or landing. Crew has no time to coordinate a course of action. Flight Attendants cannot count on the pilots for instructions and assistance in passenger evacuation. Eighty percent of emergency landings are unplanned.

PREFERRED USE OF EXITS

Availability of various exits would differ from one situation to another. Crewmembers on the scene must make the decision as to which exit would be most preferable to use under the prevailing circumstances.

PLANNED EMERGENCY LANDING

Captain:

Determine extent of emergency.

Notify ground station of emergency.

Advise flight crew and cabin crew and issue necessary orders.

If possible, avoid landing until:

- emergency equipment and crews are standing by.
- passengers are instructed in evacuation procedures.
- aircraft emergency exits are ready for use.

Warn cabin crew and passengers. Turn emergency exit lights ON. This provides a signal to the flight attendant's and passengers that ground contact is imminent and to assume the brace position.

(cont'd.)

EMERGENCY LANDING & PASSENGER EVACUATION (Not on Checklist) (cont'd.)

PLANNED EMERGENCY LANDING (cont'd.)

First Officer

Assist Captain.

Depressurize the cabin when directed.

Open cockpit door.

Secure all loose equipment in cockpit.

Help Flight Attendants prepare passengers, emergency exits, and equipment, if possible.

Actuate all switches and controls, as appropriate, just prior to touchdown.

Flight Attendant(s)

Checks with the Captain to find out:

- what the emergency is,
- how much time is left,
- what to tell the passengers, and
- how to prepare pasengers and aircraft emergency equipment.

Determine course of action as conditions warrant.

Turn on cabin lights.

Turn off galley power.

Make announcements and give instructions either over P.A. system or in person depending upon the number of passengers and the time available.

Tell passengers what the emergency is if the Captain has not done so.

Have passengers:

- fasten seat belts tight and low across hips.
- pull seats full upright.
- extinguish cigarettes.
- study Emergency Exit Diagram Cards located in their seat pockets.
- remove eyeglasses, false teeth, jewelry, ties, high-heeled shoes, and sharp objects, and place these objects in their seat pockets.

Tell passengers:

- which exits to use, if known.

(cont'd.)

EMERGENCY LANDING & PASSENGER EVACUATION (Not on Checklist) (cont'd.)

PLANNED EMERGENCY LANDING (cont'd.)

Flight Attendant(s) (cont'd.)

Flight Attendants will collect air sickness bags in a trash bag and stow in the lavatory.

Place two capable-looking men next to emergency exit windows and near emergency exit doors. Do not permit incapacitated passengers, unaccompanied children, women with babies, or elderly (senile-type) passengers to sit by these exits.

Place parents with infants:

- in rear-facing seats first.
- Place baby carriers in the lavatory.
- Wrap infants in blankets.
- Tell parents to assume bent-over brace position just prior to landing with their arms outstretched holding the infant firmly on the floor.
- Place small children capable of sitting upright without assistance in seats next to their parents.
- Pack blankets, pillows, or coats around them so seat belt can be pulled tight to hold them securely.
- Have parents assume brace position just before landing with one arm on the seat back in front and head resting on arm; and one arm on child's back to bend them forward.
- If a child is nearing 2 years of age and no spare seats are available, follow procedures for small infant.

Give pregnant women extra padding material to place between their knees and face when in brace position.

Have pregnant women fasten seat belts tight and as low as possible across their hips.

Give passengers duties (able-buddy system):

- how to open exits.
- how to use chute.
- who goes out first, second, third, etc.
- assist older passengers, children, invalids, and injured.
- check cockpit for pilots, if they don't come back to the cabin.

Remove emergency exit windows if Captain tells you and store in lavatory.

Collect and store briefcases, handbags, packages, etc., in lavatories. Lock lavatory door.

(cont'd.)

EMERGENCY LANDING & PASSENGER EVACUATION (Not on Checklist) (cont'd.)

PLANNED EMERGENCY LANDING (cont'd.)

Flight Attendant(s) (cont'd.)

Close and/or secure all galley doors, equipment, supplies, and beverage containers. Galley equipment, supplies, and beverage containers may be removed and stored, if practicable.

Secure galley curtains/door open.

Make sure all passengers know how to unfasten their seat belts.

Tell passengers:

- to assume the proper brace position, depending on seat location and orientation.
- if the landing is to be wheels-up, there are two impacts, the second being the worst.
- to remain seated in brace position until the aircraft stops all movement.

Give passengers blankets, pillows, and coats for impact protection.

Tell the Captain what you have done. Follow any additional orders he gives.

Answer passengers' questions and review the evacuation with them until ready for landing.

Have all passengers assume their proper brace positions when Captain gives the prearranged signal.

Flight Attendants sit in your assigned seat.

- fasten seat belt securely.
- keep flashlight with you.
- protect yourself with blankets or coats.
- sit upright, braced against the bulkhead with shoulder harness and seat belt tighter than tight. Place hands underneath legs, palms up to prevent flailing.

  Forward facing seats: rest chin on chest for impact.

  Rear facing seats: lean head upright resting against bulkhead, looking toward the ceiling, for impact.

- Stay in brace impact landing position until aircraft has stopped.

PASSENGER EVACUATION (LAND)
(Not on Checklist)

GENERAL

This procedure contains the steps required to prepare for passenger evacuation on land and is initiated when a condition potentially endangering life or physical well being of passengers and crew exists.

Shut down engines as soon as possible to reduce possibility of slide damage or personal injury. Time permitting, position aircraft relative to surface wind to preclude passengers exiting into or near an area when fire might be present or anticipated.

CAPTAIN - IMMEDIATE ACTION

Parking Brake - SET.

Speedbrake Handle - FULL FORWARD. This will fair spoilers in the wing allowing unobstructed route from overwing exits.

Flaps - 45°. This selection, in addition to retracting the speedbrakes, will aid passengers evacuating over the wings.

Signal Evacuation - NOTIFY TOWER/GROUND. In addition to the evacuation order, use the P.A. to issue special instructions which could render certain escape routes unaccessible.

HP Fuel Valves - SHUT. It is essential that escape slides not be deployed while engines are running.

Fire Extinguishers - As conditions warrant, use appropriate fire extinguisher on existing fires.

Battery Switch - ON.

Take Portable Fire Extinguisher and Proceed to Main Cabin - The fire extinguisher is taken as a precautionary measure. Time permitting remove flashlights, oxygen supplies, first aid kit, and blankets.

When evacuation is complete, DEPLANE by any suitable exit and take charge of ground evacuation. If unable to enter the main cabin, exit by either sliding window.

FIRST OFFICER - IMMEDIATE ACTION

Perform duties as assigned by the Captain.

APU & Engine Fire Shutoff Handles - PULL. Discharge fire bottles only if fire is a possibility in engine or APU areas. If the battery switch is ON, either shot No. 1 or shot No. 2 or the APU can be used to discharge the fire extinguishing agent. When battery switch is OFF, only shot No. 2 and the APU are available.

Emergency Exit Lights - ON.

(cont'd.)

PASSENGER EVACUATION (LAND) (cont'd.)

FIRST OFFICER - IMMEDIATE ACTION (cont'd.)

Voice Recorder C/B (#26) - TRIP. Located behind Captain's seat on Panel B-1.

Proceed to main cabin and man door not already manned by a Flight Attendant. If doors already manned, assist Flight Attendant at door if necessary.

If not needed at forward doors, proceed to overwing exits and remove exit hatches if not already removed. If overwing exit cannot be placed in seat aft of exit or out of evacuation route, throw out on wing. Leave airplane through either overwing exit and take position on wing. Assist passengers out wing, directing them aft over wing trailing edge.

FLIGHT ATTENDANTS

Remain seated until aircraft has stopped.

Evaluate situation quickly.

Give directions to able-bodied passengers to assist evacuation.

Operate assigned exits and start passenger evacuation.

Keep passengers moving out all available exits and away from aircraft. If applicable, direct evacuation through window exits deploying escape ropes.

If pilots are apparently incapacitated and you are unable to open cockpit door, seek assistance from a male passenger and attempt to KICK door IN.

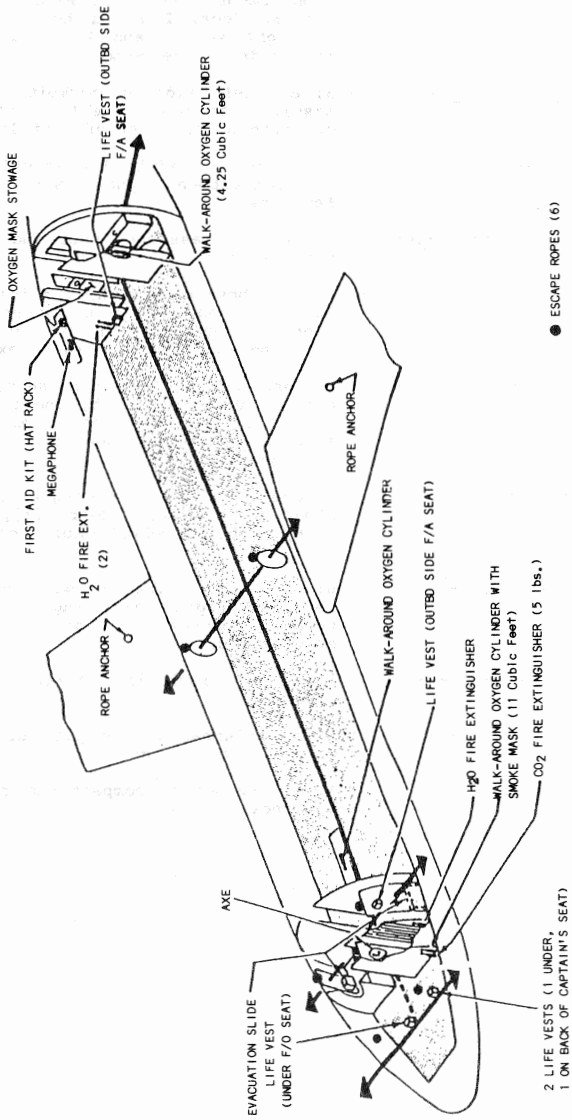
Make certain all passengers are evacuated to a safe position.

Time permitting, remove flashlights, oxygen supplies, first aid kit, and blankets as needed.

EMERGENCY EQUIPMENT AND EXIT LOCATIONS

Fire Extinguishers	4; 1 H_2O between forward coat compartment and forward passenger loading door, 2 H_2O's behind last row of right seats, and 1 CO_2 in the aft left side of the cockpit.
Portable Oxygen Bottles	3; aft left side of cockpit (full face mask), forward left hat rack, compartment just aft of left lavatory.
Oxygen Masks	5 infant & 2 adult therapeutic; stored in compartment just aft of right lavatory.
Inflatable Evacuation Slides	On forward passenger door and on galley service door.
Escape Ropes	6; one above each cockpit sliding window (2), one above forward passenger entry door (1), one above galley service door (1), one above each overwing exit (2).
Life Vests	5; one under Captain's seat, one on back of Captain's seat, one under F/O's seat, one outboard of forward flight attendant jumpseat, one in aft attendant seat base.
Portable Emergency Lights	6; one above each overwing exit (2), one above each cabin door (3), one in cockpit above cockpit-cabin door (1).
External Fixed Emergency Lights (If Installed)	6; left and right overwing exits (2), left and right rear wing fairing (2), forward passenger door (1), galley service door (1).
First Aid Kit	1; in hat rack just forward of right lavatory.
Fire Axe	1; on bulkhead in cockpit just to left of cabin-cockpit door.
Portable Megaphone	1; aft passenger compartment right hand hat rack.

EMERGENCY EQUIPMENT AND EXIT LOCATIONS (cont'd.)


OXYGEN MASK STOWAGE
LIFE VEST (OUTBD SIDE F/A SEAT)
WALK-AROUND OXYGEN CYLINDER (4.25 Cubic Feet)
FIRST AID KIT (HAT RACK)
MEGAPHONE
H_2O FIRE EXT. (2)
ROPE ANCHOR
ROPE ANCHOR
WALK-AROUND OXYGEN CYLINDER
LIFE VEST (OUTBD SIDE F/A SEAT)
H_2O FIRE EXTINGUISHER
WALK-AROUND OXYGEN CYLINDER WITH SMOKE MASK (11 Cubic Feet)
CO_2 FIRE EXTINGUISHER (5 lbs.)
ESCAPE ROPES (6)
AXE
EVACUATION SLIDE LIFE VEST (UNDER F/O SEAT)
2 LIFE VESTS (1 UNDER, 1 ON BACK OF CAPTAIN'S SEAT)

OPERATION OF EMERGENCY EQUIPMENT & EXITS

PORTABLE FIRE EXTINGUISHERS

Locations

Five portable fire extinguishers are stowed as follows:

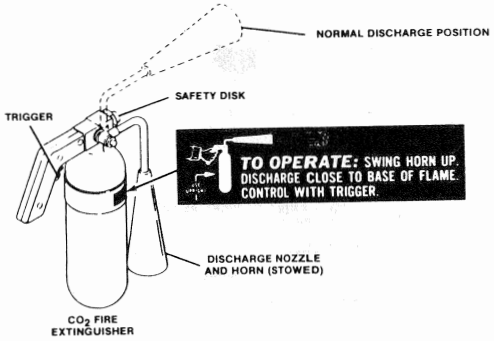
1. One CO_2 fire extinguisher on the left console to the rear of the Captain's chair.
2. One CO_2 fire extinguisher in the galley area.
3. One water fire extinguisher on the forward vestibule wall forward of the main cabin entrance door.
4. One water fire extinguisher forward end mid-cabin right couch.
5. One water fire extinguisher behind aft left couch.

CO_2 Fire Extinguisher

The CO_2 fire extinguisher contains carbon dioxide compressed to its liquid state. When the trigger is pulled the liquid escapes through a syphon tube and release valve, evaporates in the horn and discharges as a low-temperature inert cloud. The trigger controls the release valve, and is normally locked by a seal wire to show a full cylinder content; the wire is sufficiently fine to be broken by trigger pressure. The syphon tube avoids the confinement of evaporation within the cylinder and the risk of blockage due to solid CO_2 formation; it is effective so long as the cylinder is held within 45° of the vertical. The discharge is capable of both cooling and blanketing the source of fire at which it is directed; it must not be allowed to come into contact with the hands.

The CO_2 fire extinguisher may be used for all fires, but should be reserved for electrical and fluid fires.

The CO_2 hand extinguisher is considered acceptable when thermal discharge placard is not exposed and discharge trigger safety seal is unbroken.


NORMAL DISCHARGE POSITION
SAFETY DISK
TRIGGER
TO OPERATE: SWING HORN UP. DISCHARGE CLOSE TO BASE OF FLAME. CONTROL WITH TRIGGER.
DISCHARGE NOZZLE AND HORN (STOWED)
CO2 FIRE EXTINGUISHER

OPERATION OF EMERGENCY EQUIPMENT & EXITS (cont'd.)

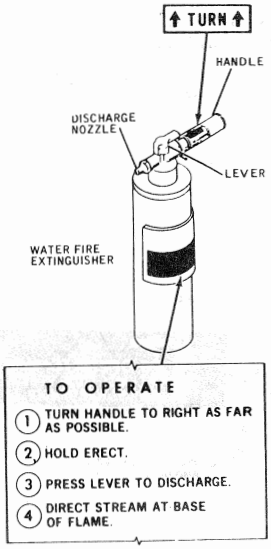
PORTABLE FIRE EXTINGUISHERS (cont'd.)

H_2O Fire Extinguisher

The water fire extinguisher contains water under normal pressure and, in the handle, a sealed bottle of compressed carbon dioxide. When the handle is twisted in the direction of the arrow, the CO_2 bottle is unsealed and the water is pressurized. When the trigger is depressed, the water escapes through a syphon tube and release valve and discharges from the nozzle. The handle is normally locked by a seal wire to show a full CO_2 bottle content; the wire is sufficiently fine to be broken by handle twist. The trigger controls the release valve. The syphon tube prevents the loss of CO_2 pressure so long as the cylinder is held within 45° of the vertical. The water is protected from the cooling effect of CO_2 expansion and low ambient temperatures by an addition of glycol anti-freeze agent.

The water fire extinguisher may be used for all but electrical and fluid fires. (Water is a sufficiently good conductor to present an electrical hazard and dense enough to sink below inflammable fluids to spread the fire.)

Water-type hand fire extinguishers are considered acceptable when CO_2 cartridge is visible through drilled hole in handle and safety seal is unbroken.



OPERATION OF EMERGENCY EQUIPMENT & EXITS (cont'd.)

PORTABLE OXYGEN SMOKE SET

One portable oxygen smoke set is stowed on the left console to the rear of the Captain's seat. The set contains an oxygen bottle and smoke mask and has a use of at least 20 minutes, with full-face smoke protection for inspection and fire-fighting work. A shoulder strap is attached to the bottle.

Oxygen Bottle

The bottle holds 310 liters of oxygen. The bottle head comprises the following items:

- A pressure gauge which shows 1800 PSI at 21°C for a full charge.
- An ON-OFF valve control knob which is turned counter-clockwise for ON.
- A pressure regulator which is preset for an outlet pressure of approximately 55 PSI.
- A relief valve which prevents excessive outlet pressure.
- An oxygen outlet connected to a demand regulator.
- An oxygen outlet for use with a rebreather mask.
- A safety plug which allows the oxygen to escape if the bottle is exposed to excessive heat.
- A charging valve which allows the bottle to be recharged, provided the ON-OFF valve is set to ON.

The demand regulator is attached to the bottle and allows oxygen to flow to a demand mask on inhalation. Inhalation causes a pressure drop at the regulator diaphragm-operated valve to allow oxygen to flow until the pressure drop is off set.

Smoke Mask

The smoke mask is connected via a breathing tube to the demand regulator outlet.

OPERATION OF EMERGENCY EQUIPMENT & EXITS (cont'd.)

EMERGENCY LIGHTING

Description & Operation

Emergency lighting is provided throughout the aircraft to provide adequate illumination if power supplies to the normal lighting circuits fail. The installation consists of two systems, No. 1 and No. 2. System No. 1 is powered by independent batteries within the emergency lighting units, while system No. 2 receives power from the 28-volt DC ESS BUS. When fully charged, the self-contained batteries in system no. 1 units will illuminate the individual lights for about 15 minutes.

Emergency exit lights located in the cockpit roof over the forward entrance door and galley door and over the left and right overwing exits are portable.

Emergency exit lights are controlled from two locations, the cockpit overhead panel and the forward attendant's panel.

Opening of DC split breaker automatically turns on system No. 1 and system No. 2. Failure of all DC power supplies turns on system No. 1 ONLY. If the emergency lights are turned OFF to conserve their self-contained batteries, it should be remembered that ESS DC power is required to turn the emergency lights back ON again.

These lights illuminate the chute and its immediate areas automatically through a lanyard control when the chute is deployed.

A walkway area over the wing roots is illuminated automatically when emergency hatches are removed.

Forward Passenger Door and Galley Service Door Butt Hook Lights

The electrical door warning system is composed of two green lights located on the forward passenger door and one red light located in the cockpit. The two green lights are labeled BUTT and HOOK. Illumination of the BUTT light indicates the door is closed, if fully down. Illumination of the HOOK light indicates the mechanical hook, located internally in the door, is in the LOCKED position. It is necessary that the microswitches for both the BUTT and HOOK light be made before the red light in the cockpit will extinguish.

The mechanical door warning system is composed of a mechanical indicator showing black diagonal lines which are visible when the door safety latch is engaged. The indicator must be visible in 100% of the window for positive door locked condition. The indicator is located directly beneath the door inner handle.

OPERATION OF EMERGENCY EQUIPMENT & EXITS (cont'd.)

BATTERY POWERED MEGAPHONE

A battery powered megaphone is installed in the cabinet over the crew coat closet or in the galley area. Its use may prove beneficial in directing passenger evacuation in the event that electrical power is not available.

To operate, depress the trigger button in the pistol grip when speaking, adjusting the volume control button as necessary.

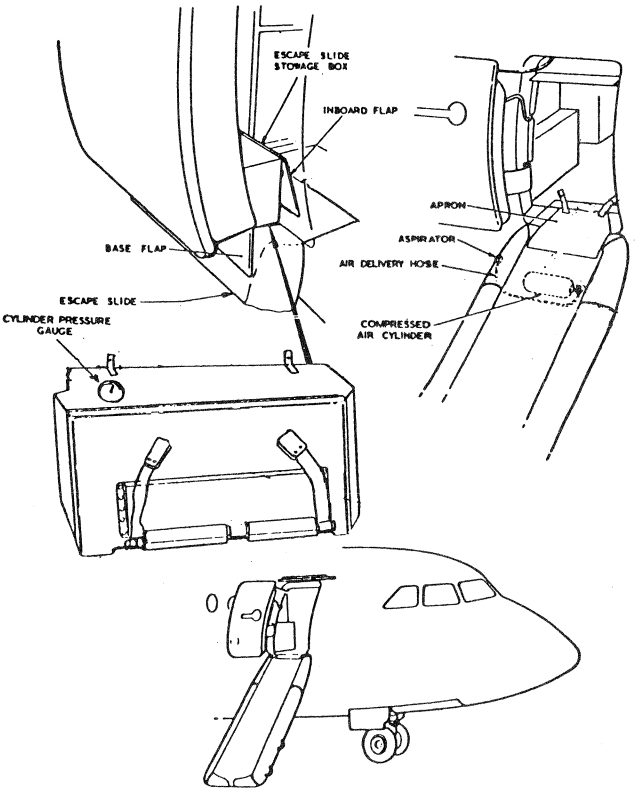
OPERATION OF EMERGENCY EQUIPMENT & EXITS (cont'd.)

EVACUATION CHUTES

The inflatable chutes located at the bottom of the forward passenger and galley doors are ready for use, provided that air pressure is in the green arc and the fasteners are hooked to the vestibule floor attachment fixtures.

Opening a door from inside or outside the aircraft with a firm and decisive action pulls the slide pack from its stowage box. The chute will then fall below the door sill exposing a red grip handle on the slide pack. By pulling on the red grip, the chute will inflate in 3 seconds.

Should the chute fail to inflate, there are two handles that can be used to support the chute by two able-bodied people for emergency evacuation.

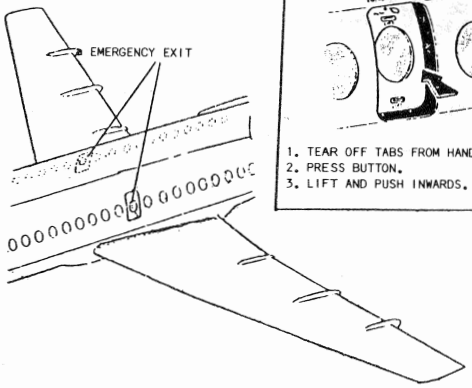


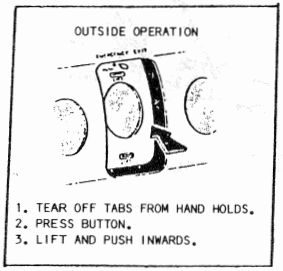
OPERATION OF EMERGENCY EQUIPMENT & EXITS (cont'd.)

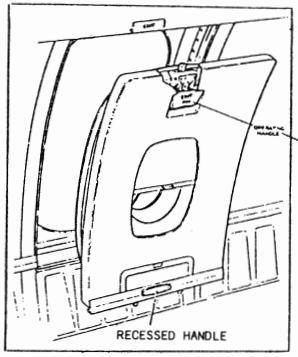
OVERWING EXIT

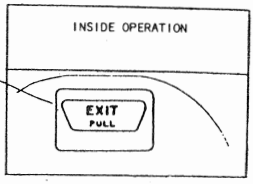
All aircraft windows pull IN to remove. The aircraft must be depressurized before they open.

- Pull handle IN toward aisle.
- Pull window IN, turn it on its side, then throw it out.





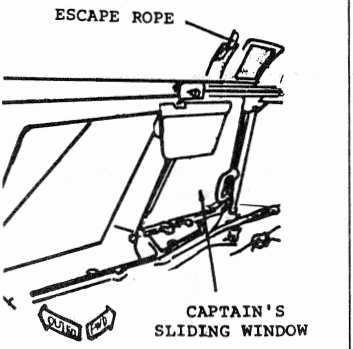




PLACARDS TYPICAL LEFT AND RIGHT EMERGENCY WINDOW

OPERATION OF EMERGENCY EQUIPMENT & EXITS (cont'd.)

COCKPIT WINDOW EXITS



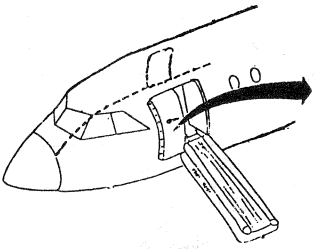
If evacuation of the cockpit is not possible through the cabin, pull the cover plate from the emergency escape strap, check that the strap is anchored to the airplane, deploy the line out the cockpit window and descend to the ground. Assist from outside during an emergency evacuation, if possible.

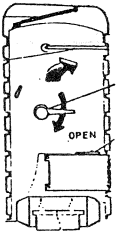
OPERATION OF EMERGENCY EQUIPMENT & EXITS (cont'd.)

PASSENGER & GALLEY DOORS

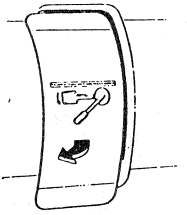
1. Check for slide retainer straps secured in floor fittings.
2. Open door all the way forward. The slide then pulls free from the slide container.
3. Be sure slide drops down over edge of door frame. Pull slide inflation handle.

   DO NOT release slide, pull slide inflation handle, or open door while aircraft is moving.





INSIDE OPERATION
1. Push handle down to open position
2. Push door out

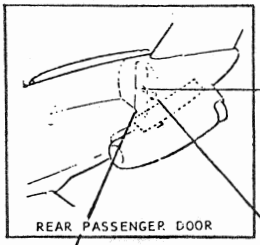


OUTSIDE OPERATION
1. PULL HANDLE OUT
2. TURN HANDLE
3. PULL DOOR OUTWARDS

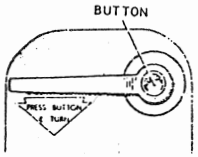
OPERATION OF EMERGENCY EQUIPMENT & EXITS (cont'd.)

REAR DOOR EXIT

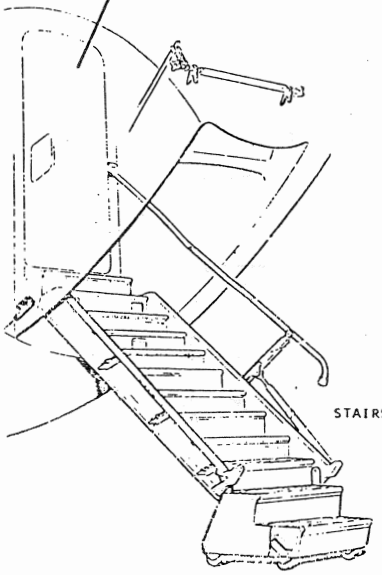
1. Secure rear cabin door OPEN.



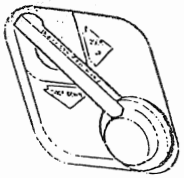
1. Press in on button.
2. Push handle down.
3. Pull door towards you to open.



REAR PASSENGER DOOR HANDLE



STAIRS LOWERED



1. Pull stair handle out.
2. Push handle Down to "OPEN" position. Stairs lower.
3. Pull handle back to "NEUTRAL" position.

REAR PASSENGER STAIR HANDLE

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ABNORMAL PROCEDURES

FOREWORD

Abnormal procedures set up in this manual were included only after repeated testing and investigation. They represent the best known available facts about the subject. Pilots should follow these procedures as long as they fit the abnormal condition. However, if at any time they are not adequate or do not apply, the Captain's best judgment should prevail. Only the flight crew operating the airplane at the time the abnormal situation occurs can evaluate the situation sufficiently to make the proper decision.

The procedures are essentially the same as those contained in the FAA Approved Flight Manual. Certain changes to the manufacturer's recommendations in operating technique have been made. These differences have been found as a result of experience to be in consonance with and in the best interest of safety and good operating practice.

All crewmembers should be thoroughly familiar with abnormal procedures and should be equipped to handle the duties of any other crewmember.

Obviously, all abnormal situations which could occur could not be included in this handbook.

Abnormal checklists are used in the same **CHALLENGE and RESPONSE** method as the Normal checklists but with this additional step: The pilot reading the checklist should read aloud **BOTH the CHALLENGE and the RESPONSE.** Then there should be no doubt in any flight crewmember's mind as to the correct course of action. The pilot responding has the same responsibility for checking and/or accomplishing the item and responding to the Challenge as if it were not being read aloud.

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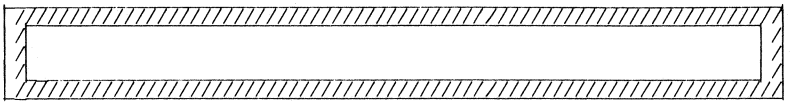
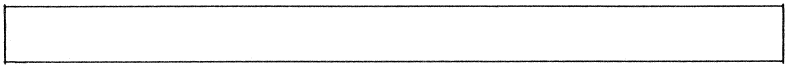
ABNORMAL PROCEDURES

CHECKLIST AMPLIFICATION

Checklist Emergency/Abnormal and Normal titles are contained in this type box:



Procedural titles are contained in this type box:



Procedural steps in the flow pattern of a particular procedure may or may not be contained in this type box:

SECTION 1-301

AIR CONDITIONING AND PRESSURIZATION

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DIFFERENTIAL PRESSURE GRAPH	1-301-6
LOSS OF NORMAL CABIN PRESSURIZATION CONTROL	1-301-4

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TO GRADUALLY DEPRESSURIZE

Cabin Altitude Selector - SELECT AN ALTITUDE ABOVE AIRCRAFT. Cabin will climb to new altitude at desired rate.

Safety Valve - OPEN, when near minimum differential. Expect activation when differential becomes less than 1 PSI.

Ram Air Valve - OPEN. The ram air valve, located in the No. 2 air conditioning refrigeration unit under right side of aircraft, right side, will open when the aircraft becomes depressurized.

TO RAPIDLY DEPRESSURIZE

MAC Valves - CLOSED. Stops all incoming air.

Manual Dump - OPEN. Press air dump valve handle down and turn clockwise until indicator shows full open.

Safety Valve - OPEN. Expect activation when differential pressure becomes less than 1 PSI.

Ram Air Valve - OPEN. The ram air valve, located in the No. 2 air conditioning unit under right side of aircraft will open when the aircraft becomes depressurized.

CABIN ALTITUDE WARNING LIGHT

Warning Light and Cabin Pressure Controller Setting - CHECK. Warning light will illuminate and horn will sound at approximately 10,000 feet cabin altitude.

Emergency Descent - INITIATE IMMEDIATELY, if necessary.

Oxygen Masks - DON. Regulators 100% and emergency levers ON, if required.

Cockpit Speakers - ON. Use head sets, if desired.

Interphone Microphone Selector - NORM INT or EMERG INT.

Duct Pressure - CHECK. Check mains pressure for discrepancy.

MAC Valves - CHECK OPEN. At least one MAC valve must be open.

Discharge Valve - NORMAL OR CLOSED. If pressure normal and discharge valve closed, check for open door, blown window, etc.

Refer to LOSS OF NORMAL CABIN PRESSURIZATION CONTROL abnormal procedure in this section or EXPLOSIVE OR RAPID DECOMPRESSION emergency procedure in Chapter 1 - EMERGENCY.

LOSS OF NORMAL CABIN PRESSURIZATION CONTROL

In the event cabin will not pressurize normally or cabin altitude climbs to 9,000 feet, proceed as follows:

Pressure Controller - CHECK PROPERLY SET. Check airflow into the airplane (isolation valves, fail lights, etc.).

Outflow Valve - CHECK CLOSED. Determined by discharge valve position indicator.

If pressure controller and/or outflow valve are not functioning properly:

Air Dump Valve Knob (Right Console) - DEPRESS AND TURN CLOCKWISE. Depress and turn until discharge valve position indicator just begins to move.

Air Cond. Pressure Control C/B #53 (Panel B-1) - TRIP. This deactivates automatic pressure control.

Air Dump Valve Knob - DEPRESS AND SLOWLY ROTATE TOWARDS CLOSE (COUNTERCLOCKWISE). Continue until desired cabin pressure is achieved.

CAUTION: In effect, the air dump valve is connected directly to the outflow valve, so movement should be limited only to that required to get smooth pressure changes. Large movements will result in abrupt and excessive pressure changes.

If the preceding is not successful, the problem is probably due to a cabin pressure leak; in which case, determine source of leak and proceed as follows:

If leak is around a plug-type door:

Do not attempt to reseat door in flight. Instead, seal leak with pillows, towels, etc., then attempt to pressurize the cabin again.

CAUTION: Do not stuff pillows, towels, etc., in leaks other than leaks around plug-type doors.

If leak is not around a plug-type door or if source of leak cannot be determined:

Operate airplane unpressurized. Refer to EXPLOSIVE OR RAPID DECOMPRESSION emergency procedure in Chapter 1 - EMERGENCY.

SUDDEN CABIN DIVE

MAC Valves - BOTH CLOSED.

Pressure Controller C/B #53 (Panel B-1) - TRIP.

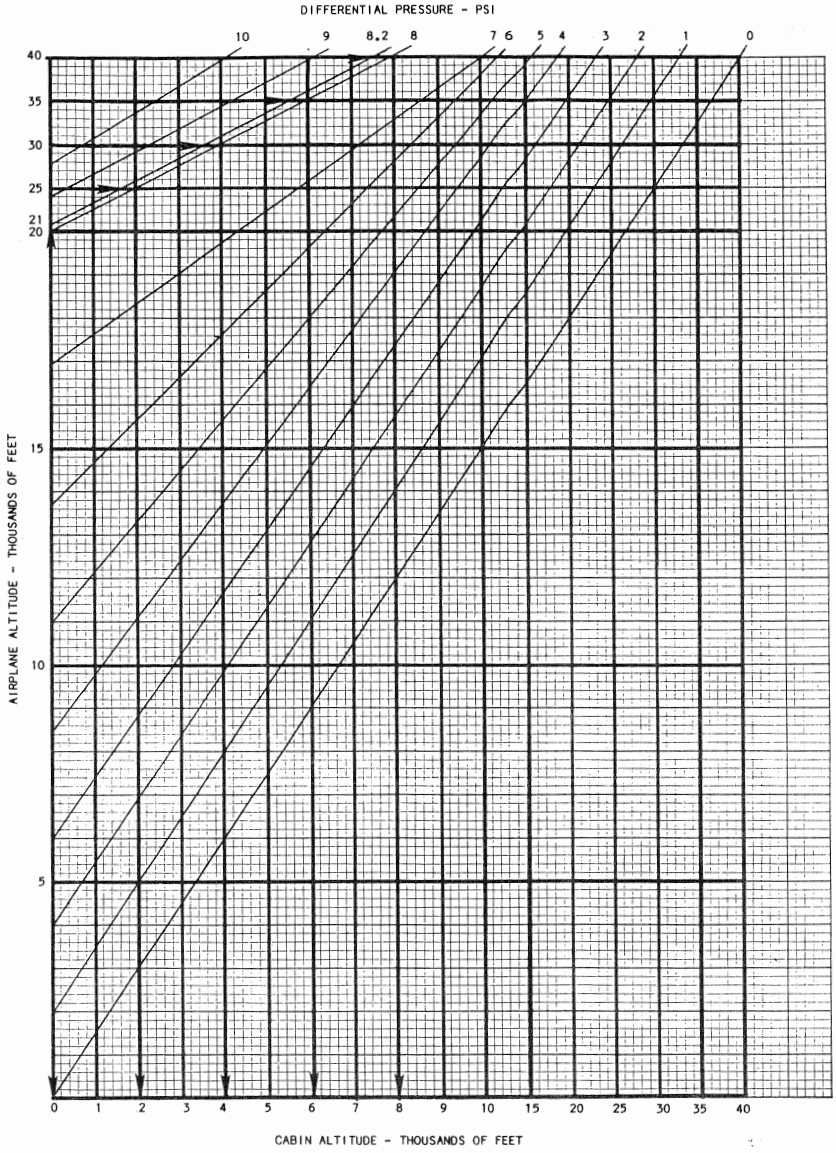
MAC Valves - OPEN ONE.

Air Dump Valve - INITIATE MANUAL CONTROL.

MAC Valves - BOTH MAY BE UTILIZED.

DIFFERENTIAL PRESSURE GRAPH

The following graph presents varying cabin altitudes and/or pressure differentials associated with selected flight altitude.



SECTION 1-302

APU

CROSS REFERENCE

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SECTION 1-303

BRAKES

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BRAKE TEMPERATURE	1-303-1
FAILURE OF NORMAL BRAKE SYSTEM	1-303-2

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BRAKE TEMPERATURE

If for any reason the brake temperature of any wheel is more than 400°C, the gear must not be retracted until the temperature has reduced to this figure.

In the event of engine failure during takeoff, this limitation must be ignored until obstacle clearance is assured, at which time, the gear must be extended until the brake has cooled to 400°C or less.

Supplied by Jeppesen Sanderson

FAILURE OF NORMAL BRAKE SYSTEM

In the event of failure of the normal foot-operated brake system, apply the hand brake. Considerable care must be taken when using the hand brake since no anti-skid device is installed in this system and no differential braking is available. The standby (hand) brake system accumulator has sufficient pressure capacity for at least 6 full-brake applications.

Supplied by Jeppesen Sanderson

AUTO-BRAKE PRESSURE REMAINS ON

If the hand brake pressure gauge indicates a pressure after the landing gear has been retracted, due to the automatic brake application during retraction, PULL and RELEASE the parking brake handle.

Check brake pressure indication. In most cases, the pressure will remain as before or increase slightly. In some cases, the pressure may fall to zero. If hand brake pressure is indicated, it should fall to zero when the landing gear is extended on approach.

After gear extension, check hand brake pressure at zero. If pressure does not return to zero, assume brakes will be ON at touchdown.

ANTI-SKID INOPERATIVE OR ANTI-SKID FAILS TO TEST PROPERLY

If anti-skid test does not give proper indications or the system is inoperative:

Anti-skid Switch - OFF. Select anti-skid control switch to OFF. This will preclude the possibility of a complete brake failure at slow airplane ground speeds.

Increase required landing distance by 40%. With the anti-skid selected to OFF, differential foot brakes are available, but with no anti-skid protection. Avoid excessive braking that could cause tire damage.

CAUTION: It should be kept in mind that if the landing gear control handle cannot be placed in the DOWN position, the anti-skid will be inoperative.

SECTION 1-304

DOOR AND WINDOWS

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FRONT PASSENGER, GALLEY, CARGO OR BAY DOOR WARNING

Pressurization - MAINTAIN NOT LESS THAN 1.0 PSI.

Cross Hatch Indicator - CHECK. DO NOT TOUCH DOOR HANDLE. If the cross hatch indicator fills the window, the door is safe. If the indicator partially fills the window, maintaining not less than 1.0 PSI should hold the door in place.

NOTE: The cross hatch indicator is not in electric bay.

REAR PASSENGER DOOR WARNING

Rear Passenger Door (Bulkhead) - CHECK CLOSED.

Ventral Stair Unlock Light - EXTINGUISHED. The warning light is located in the ventral area. If the stairs are unlocked, the cockpit rear door warning light will be illuminated, in addition to the ventral stairs unlock light.

If the warning light remains illuminated:

Make a gentle descent and land as soon as practicable. DO NOT USE SPEED BRAKES.

WINDSHIELD OR SIDE WINDOW GLASS FAILURE

GENERAL

Each windshield and side window panel includes 3 panels of glass of which the middle is the main load-bearing member. Failure of any panel shows up as granular crazing over the entire surface and it is not easy to distinguish which has failed. If the outer fails, the metal insert around the edges of the window remains clearly visible, but if the middle or inner panel fails, the insert will be obscured by the crazing.

If the inner panel has failed, it may be possible to detect this by feel, particularly near the edges, but unless this check is quite positive, it must be assumed that the middle has failed if the metal insert is obscured.

Failure of the windshield outer glass or the side window middle glass causes the heating to that panel to fail.

Because of the difficulty of distinguishing the exact failure, it is recommended that the procedure below, "Unidentified Glass Failure", be followed as soon as possible. If the exact failure can immediately or subsequently be established, the other procedures, as appropriate, may be used.

UNIDENTIFIED GLASS FAILURE

- Cabin altitude selector to 8,000 feet.
- Descend, if required, to 2.5 PSI maximum differential (16,000 feet).
- Below 8,000 feet, restrict speed to 190 knots IAS maximum if windshield failure.
- The use of smoke goggles is recommended.

MIDDLE GLASS FAILED

- Cabin altitude selector to 8,000 feet.
- Descend, if required, to 2.5 PSI maximum differential (15,000 feet).
- Restrict speed below 8,000 feet in accordance with the AIRSPEED LIMITS chart in this section.

OUTER GLASS FAILED (WINDSHIELD)

- Cabin selector to 8,000 feet.
- Descend, if required, to 5.5 PSI maximum differential (25,000 feet).
- Restrict speed below 8,000 feet in accordance with the AIRSPEED LIMITS chart in this section.

OUTER GLASS FAILED (SIDE MAIN WINDOW)

- No action required.

INNER GLASS FAILURE

- No action is required. Crazing and cracks are not critical.
- The use of smoke goggles is recommended.

(cont'd.)

WINDSHIELD OR SIDE WINDOW GLASS FAILURE (cont'd.)

CRACKS AND CRAZING

At the Captain's discretion, the aircraft may remain in service with a cracked or crazed outer windshield glass panel provided:

- The crack is restricted to the outer glass with no loose pieces.
- Visibility is not impaired.
- Flight not to be attempted in icing conditions.
- The aircraft is operated at a cabin pressure differential not to exceed 5.5 PSI maximum and airspeed restricted below 8,000 feet in accordance with the AIRSPEED LIMITS chart in this section.
- Deactivate windshield anti-ice circuits by pulling AC circuit breakers on Panel B, behind the left cockpit chair.

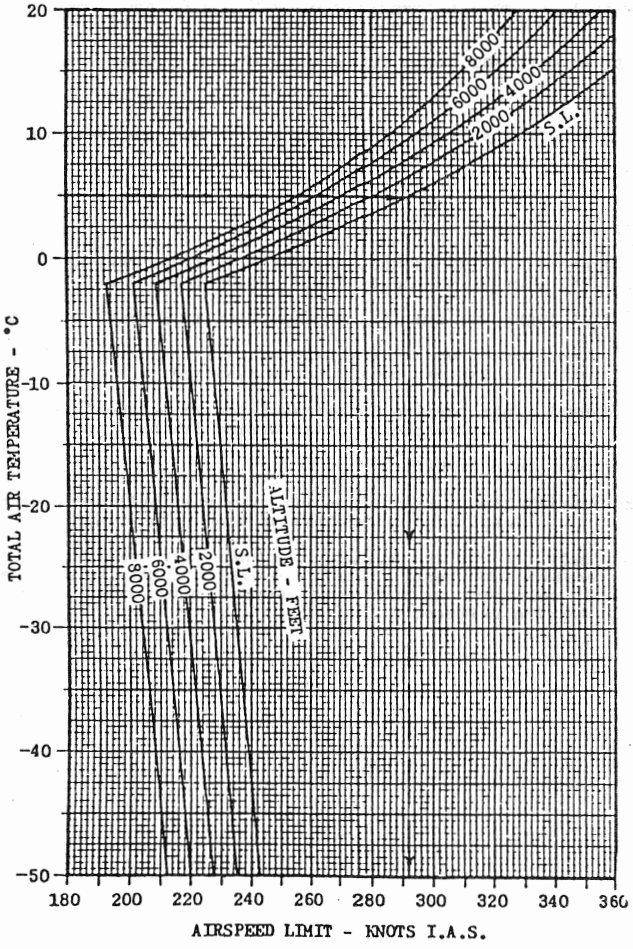
ANTI-ICE MAIN SCREEN CIRCUIT BREAKERS

Left: B-66 B-82
Right: B-59 B-89

MAIN SCREEN UNDERHEAT WARNING CIRCUIT BREAKERS

Left: B-170
Right: B-169

AIRSPEED LIMITS
WINDSHIELD HEAT INOPERATIVE OR WINDSHIELD DAMAGED



WINDSHIELD OVERHEAT LIGHT(S) ON

ON-THE-GROUND:

It is normal for windshield overheat light(s) to be illuminated on the ground with high ambient temperatures (90°F/32°C) and remain illuminated for 5 to 10 seconds after takeoff.

If an OVERHEAT light illuminates with HIGH heat selected:

Reselect LOW.

If an OVERHEAT light illuminates with LOW heat selected:

No action is required.

IN-FLIGHT:

If the overheat light(s) do not extinguish after approximately 10 minutes after takeoff, accomplish the following procedures as outlined below:

If an OVERHEAT light illuminates with HIGH heat selected:

Since all electrical power to the windshield is normally removed when its overheat light illuminates, no action is required.

If an OVERHEAT light remains illuminated for an extended period of time or reappears after extinguishing:

LOW heat should be selected.

If an OVERHEAT light illuminates with LOW heat selected or remains illuminated regardless of heat selection:

Turn heat selector to OFF position. When the overheat light extinguishes, reselect LOW heat. If the overheat light illuminates again, return heat selector to OFF and observe same restrictions as for Windshield Heating Failure.

WINDSHIELD AND/OR SIDE MAIN WINDOW UNDERHEAT OR HEATING FAILURE

WINDSHIELD UNDERHEAT OR HEATING FAILURE:

If windshield underheat light illuminates with LOW selected:

Set the windshield heat switch to HIGH.

If windshield underheat light illuminates with HIGH selected or remains illuminated regardless of LOW or HIGH selection:

Leave the windshield heat switch in HIGH position.

If underheat warning continues for more than 3 minutes or heating to either windshield fails:

Airspeed should be restricted below 8,000 feet according to the AIRSPEED LIMITS chart in this section.

In all cases, before accepting the loss and the possible restrictions, check windshield heat circuit breakers:

- Anti-ice Main Screen C/B's: Left #B-66 & #B-82
  Right #B-59 & #B-89

- Main Screen Underheat Warning C/B's: Left #B-170
  Right #B-169

SIDE WINDOW HEATING FAILURE:

Side Window Heat C/B's (Left #65 & #51, Right #58 & #72) - CHECK. If circuit breakers tripped, RESET and check operation. If circuit breakers okay or trip after being reset, accept loss. No further action is required.

CABIN WINDOW FAILURE

Each cabin window consists of 2 panels of which the inner panel is normally the load bearing member, although either is capable of carrying the load.

In the event of failure of either panel, the cabin differential pressure must be reduced to not more than 5.5 PSI as soon as practicable.

Move passengers from seats adjacent to the failed window.

NOTE: If a cabin altitude of 8,000 feet is to be maintainted, a cabin differential pressure of 5.5 PSI will require an aircraft altitude of 25,000 feet. A higher aircraft altitude is permissible if a higher cabin altitude is acceptable.

DV WINDOW USE IN FLIGHT

It is highly unlikely that the DV (sliding) windows will ever have to be opened in flight. However, if the situation should occur when direct forward outside vision is not possible due to extreme windshield icing (windshield heat inoperative), badly damaged windshields, or heavy concentrations of smoke in the cockpit, the opening of one DV window may be desirable.

CAUTIONS:

- Open only one DV (sliding) window.
- Opening a DV (sliding) window will clear the cockpit of smoke in a matter of seconds, but it should be kept in mind that the air from the open window may aggravate or even restart the fire.
- Never open a DV (sliding) window to clear smoke in the cabin. This will only draw the cabin smoke into the cockpit.
- Assure that the cockpit-to-cabin door is closed before opening a DV (sliding) window.

BEFORE OPENING DV (SLIDING) WINDOW:

- Descend to an altitude where the airplane can be depressurized, normally on approach.
- Use normal flap extension schedule. Slow to 160 knots or less.
- Both Air Conditioning Master Valves - CLOSED.
- Ram Air Valve - CLOSED.
- Open one sliding window.

NOTE: There is no limitation on airspeed for opening or closing a DV (sliding) window in flight, but at speeds in excess of 160 knots, the noise level becomes such as to render interphone and radio communications marginal.

Operations above 180 knots could cause damage to the window's operating mechanism.

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SECTION 1-305

ELECTRICAL

SUBJECT	PAGE NO.
AC BUS FAIL LIGHT	1-305-1
CSDS FAIL LIGHT	1-305-2
DC BUS FAIL LIGHT	1-305-3
ELECTRICAL SYSTEM FIRE OR SMOKE:	
- Block Diagram	1-305-6
- Reinstatement I	1-305-5
- Reinstatement II	1-305-5
GENERATOR FAIL LIGHT	1-305-4

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AC BUS FAIL LIGHT

Bus Output - CHECK. Check availability of equipment on the bus with fail light illuminated. The warning could be false.

Generator Switch - RESET ONE TIME ONLY. Select voltage/frequency selector to affected side and reset generator one time only. Also, check KVA load.

If fail light remains illuminated or cycles with generator light:

Generator - TRIP. Accept loss on the affected side. Do not attempt to use APU generator on a shorted bus.

If the light flickers excessively:

Volts and Frequency - CHECK. Voltage and frequency should be monitored frequently. Some flickering of the light normally occurs with certain airplane maneuvers (e.g., takeoff rotation, etc.). However, if flickering is excessive or light remains illuminated steady, this condition should be noted in the log book so that Maintenance will take corrective action.

If voltage and/or frequency is abnormal:

CSDS - DISCONNECT. Leave the switch in this position for the remainder of the flight.

CAUTION: CSD cannot be reconnected in flight. Returning switch to NORMAL could cause extensive damage to CSD.

DC BUS FAIL LIGHT

DC Split C/B #335 (F/O's Side C/B Panel) - CHECK IN. If tripped, RESET.

#1 & #2 TRU C/B's #17 & #18 (Left Strip Panel in Companionway) - CHECK IN. If tripped, RESET.

TRU Amps Gauge (Overhead Electrical Panel) - CHECK. Check TRU Amps gauges to see if TRU's are operating normally.

If both show output:

DC Split C/B (Right Console) - CHECK. If breaker OKay, no further action is required. There should be no loss of any DC service.

If #1 shows no output:

DC Split C/B (Right Console) - CHECK. If breaker OKay, ESS DC bus is being fed by the batteries. Use battery switch to control bus availability as necessary.

If #2 shows no output:

DC Split C/B (Right Console) - CHECK. If breaker OKay, services on Main DC bar are inoperative.

If both show no output:

DC Split C/B (Right Console) - TRIP (OR DO NOT RESET). Services on Main DC bus are are inoperative. Use battery switch to control availability of ESS DC bus as required.

NOTE: Opening of DC Split C/B will cause emergency exit lights to illuminate, if emergency light switch is in the ARMED position. In this case if no emergency exists, the emergency lights should be turned OFF to preserve their self-contained batteries. Before taking this action, however, bear in mind that ESS DC power will be required to turn them back on again.

GENERATOR FAIL LIGHT

Volts & Frequency/Generator Switch - CHECK/RESET ONE TIME ONLY. Select generator on affected side on frequency selector switch, then check cycles and volts while resetting.

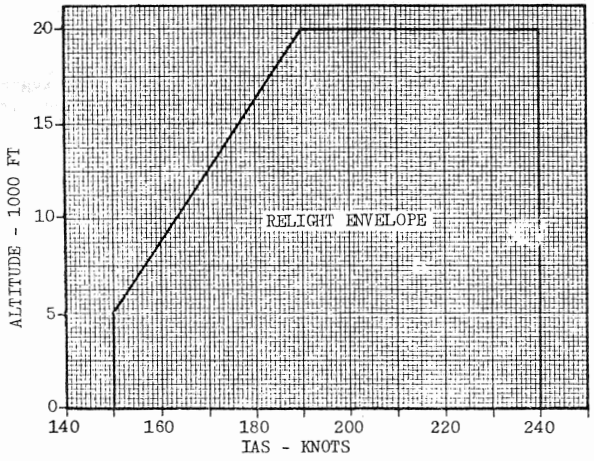
NOTE: It may be necessary at engine speeds in excess of 90% N2 RPM to reduce power momentarily in order to achieve a generator reset.

If generator fails to reset, accept loss.

If generator warning light (with or without bus light) is cycling on and off, accept loss. Trip generator on affected side and accept loss. Check generator KVA meter; if abnormal, DO NOT USE APU.

APU - START. Start and operate generator in either of the above cases, except for an abnormal KVA meter reading after a generator is tripped. Start APU, select APU generator position on frequency selector switch, and reset APU generator and use.

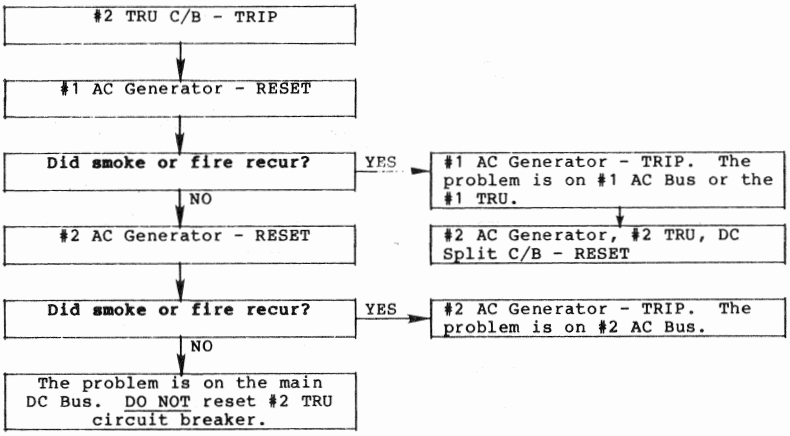
APU INFLIGHT RELIGHT ENVELOPE



ELECTRICAL SYSTEM FIRE OR SMOKE

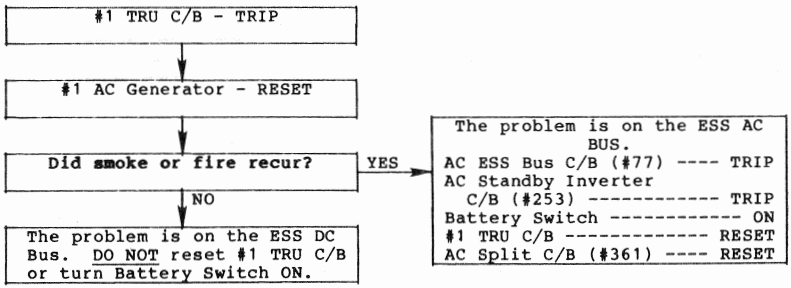
REINSTATEMENT I

NOTE: Before beginning this procedure, determine if reinstatement of #1 AC bus, #2 AC bus, or Main DC bus is necessary for the safe continuation of the flight.


#2 TRU C/B - TRIP
#1 AC Generator - RESET
Did smoke or fire recur?
YES
#1 AC Generator - TRIP. The problem is on #1 AC Bus or the #1 TRU.
#2 AC Generator, #2 TRU, DC Split C/B - RESET
NO
#2 AC Generator - RESET
Did smoke or fire recur?
YES
#2 AC Generator - TRIP. The problem is on #2 AC Bus.
NO
The problem is on the main DC Bus. DO NOT reset #2 TRU circuit breaker.

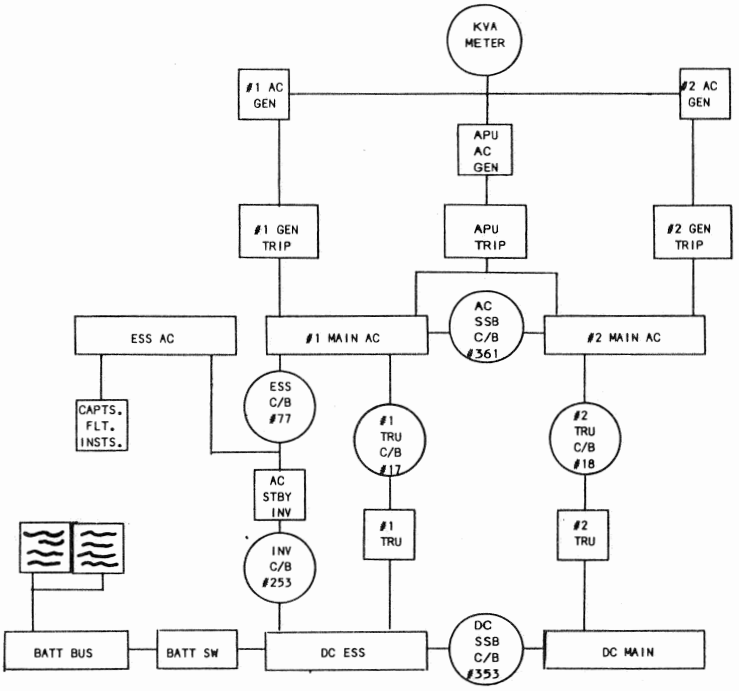
REINSTATEMENT II

NOTE: Before beginning this procedure, determine if reinstatement of the #1 AC Bus, ESS AC Bus, or ESS DC Bus is necessary for the safe continuation of the flight.


#1 TRU C/B - TRIP
#1 AC Generator - RESET
Did smoke or fire recur?
YES
The problem is on the ESS AC BUS.
AC ESS Bus C/B (#77) ---- TRIP
AC Standby Inverter C/B (#253) ---------- TRIP
Battery Switch ---------- ON
#1 TRU C/B ---------- RESET
AC Split C/B (#361) ---- RESET
NO
The problem is on the ESS DC Bus. DO NOT reset #1 TRU C/B or turn Battery Switch ON.

ELECTRICAL SYSTEM FIRE OR SMOKE (cont'd.)

BLOCK DIAGRAM



SECTION 1-306

FIRE PROTECTION

SUBJECT — PAGE NO.

CROSS REFERENCE

EMERGENCY PROCEDURES:

APU FIRE ---------- 1-40-1

APU FIRE ON-THE-GROUND (Not on Checklist) ---------- 1-40-3

ENGINE FIRE ---------- 1-20-1

ENGINE FIRE ON-THE-GROUND (Not on Checklist) ---------- 1-35-3

ENGINE OVERHEAT ---------- 1-15-1

EXCESSIVE TGT (Not on Checklist) ---------- 1-35-2

INFLIGHT START ---------- 1-30-1
- Emergency Restart ---------- 1-30-1
- Normal Restart ---------- 1-30-1
- Relight Envelope ---------- 1-30-3

LANDING GEAR FIRE ON-THE-GROUND (Not on Checklist) ---------- 1-35-4

OIL PRESSURE LOW LIGHT ON (Not on Checklist) ---------- 1-35-1

SECONDARY ACTIONS ---------- 1-25-1

SMOKE EVACUATION - AIRCRAFT PRESSURIZED ---------- 1-50-1

SMOKE EVACUATION - AIRCRAFT UNPRESSURIZED ---------- 1-55-1

SMOKE FROM AIR CONDITIONING SYSTEM ---------- 1-45-1

SMOKE OR FIRE PROCEDURES (Not on Checklist):
- Air Conditioning ---------- 1-60-1
- Diagnosis ---------- 1-60-1
- Electrical ---------- 1-60-1
- Freight Holds ---------- 1-60-1
- General ---------- 1-60-1

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SECTION 1-307

FLIGHT CONTROLS & AUTOPILOT

SUBJECT — PAGE NO.

AUTOPILOT:

ALTITUDE LOSSES CAUSED BY MALFUNCTIONING ---------- 1-307-15

AUTOMATIC DISENGAGEMENT IN FLIGHT ---------- 1-307-13

EMERGENCY DISENGAGEMENT ---------- 1-307-14

FAILURE TO ENGAGE ---------- 1-307-12

FLIGHT CONTROLS:

FEEL SIMULATOR FAIL ---------- 1-307-2

FLAP PRIMARY SHAFT FAIL LIGHT ON ---------- 1-307-6

FLIGHT ABOVE Vmo/Mmo ---------- 1-307-5

HORIZONTAL STABILIZER INOPERATIVE ---------- 1-307-8

HORIZONTAL STABILIZER (TPI) LIGHT ON ---------- 1-307-7

JAMMED ELEVATOR CAUSED BY STICK PUSHER MALFUNCTION ---------- 1-307-9

MACH TRIM SYSTEM ---------- 1-307-10

RUDDER CONTROL MALFUNCTION ---------- 1-307-16

RUDDER FEEL FAIL LIGHT ON IN FLIGHT ---------- 1-307-1

SPOILERS AND/OR LIFT DUMPERS INOPERATIVE ---------- 1-307-4

SPOILER FAIL LIGHT ON ---------- 1-307-3

STALL PROTECTION:
- General Failures ---------- 1-307-11
- Heater Monitoring ---------- 1-307-11

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RUDDER FEEL FAIL LIGHT ON IN FLIGHT

Intermittent illumination of the feel warning light is not abnormal, particularly on the ground when large rudder movements are made.

If the light remains illuminated for 10 seconds or longer, with both hydraulic systems pressurized and both flight controls cutoff levers in ON position, check Q-pitot heater ammeters. If indications are satisfactory, no further action is necessary, except autopilot should be disengaged during initial approach (at about 5,000 feet AGL) and a gentle check of rudder and elevator should be performed.

Autopilot may be re-engaged following rudder and elevator check.

A small increase in feel force may be noticeable when the light is illuminated.

If light extinguishes after being illuminated, press-to-test light cap to confirm that light is serviceable.

All cases of light remaining illuminated continuously for unknown reason should be recorded in log book.

NOTE: Q-pitot heat operation is indicated on P-3 and P-4 ammeters. Circuit Breakers are located on Panel B-1 behind left cockpit chair (C/B #49 left and C/B #57 right).

Controls Feel Very Light:

Handle aircraft controls very gently, slow to approach speeds (preferably with autopilot), and land as soon as practicable.

SPOILER FAIL LIGHT ON

INDICATES: Seizure of a Spoiler Control Valve

Respective Spoiler Switch - OFF, and leave OFF for remainder of flight. Spoiler fail light will extinguish when switch is moved to OFF.

See abnormal procedure SPOILERS AND/OR LIFT DUMPERS INOP in this section.

SPOILERS AND/OR LIFT DUMPERS INOPERATIVE

In flight, with one pair of spoilers inoperative (isolated), there is no noticeable difference in flight handling qualities, except at low speeds, roll rate with large control deflections is somewhat reduced. With both sets of spoilers inoperative, there is a noticeable reduction in roll rate.

For landing with spoilers and/or lift dumpers inoperative, the required landing distance should be increased by about 10% for each set of spoilers (or lift dumpers) that are inoperative.

FLIGHT ABOVE Vmo/Mmo

In the event of Vmo or Mmo being inadvertently exceeded, the ailerons become heavy and, at very high speed, high loads will be required for lateral control.

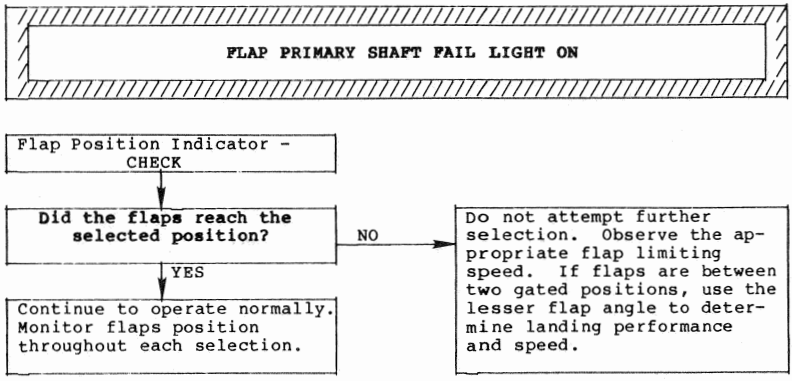
Beyond about 40 knots above Vmo, there may be a small lateral trim change, but lateral trim should not be used because of the resulting out-of-trim forces when normal flight is regained.

Longitudinal stability deteriorates above Mmo, but this is alleviated by the Mach trim system.

If Mmo is significantly exceeded, IMMEDIATE ACTION must be taken to restore the aircraft to within the operating speed limit by reducing power, leveling the aircraft laterally, and then extending the speed brakes.

Above about Mach .81, the rolling effect caused by the use of rudder reverses. For this reason, aileron only should be used above this speed to maintain lateral control.

At high speeds, at forward CG loadings, elevator forces for maneuvering are high. In the event of extreme maneuvers being required, it is permissible to use stabilizer trim to assist, provided that only low rates of trim are used and that considerable care is taken.


FLAP PRIMARY SHAFT FAIL LIGHT ON
Flap Position Indicator - CHECK
Did the flaps reach the selected position?
NO
Do not attempt further selection. Observe the appropriate flap limiting speed. If flaps are between two gated positions, use the lesser flap angle to determine landing performance and speed.
YES
Continue to operate normally. Monitor flaps position throughout each selection.

HORIZONTAL STABILIZER (TPI) LIGHT ON

INDICATES: Malfunction of Respective Stabilizer Control Valve.

Respective TPI Switch - OFF, and leave OFF for remainder of flight. Light will extinguish when switch is selected to OFF.

No further action is required. Stabilizer should operate normally.

HORIZONTAL STABILIZER INOPERATIVE

In the event of the tailplane being jammed in the CRUISE position, or inability to move it for any other reason, every effort should be made to move the CG as far back as possible within the normal limits. Movement of passengers is an effective means of achieving this.

No trimming is available, but adequate controllability has been demonstrated in this condition, although stick forces can be quite high.

Except when the flaps are down, there is no limitation on the use of speed brakes in this condition.

A longer final approach should be made, reducing speed within gear and flap limits.

NOTE: With stuck or chattering TPI trim, turn mach trim OFF, then ON, which might correct problem.

JAMMED ELEVATOR CAUSED BY STICK PUSHER MALFUNCTION

Following stick pusher actuation, should the control column be held forward, immediately operate the dump valve lever. In the unlikely event that the control column cannot be moved aft after the dump valve lever is operated (jammed stick pusher), apply nose-up stabilizer as rapidly as possible until the airplane is restored to an in-trim condition; then:

- Airplane handling characteristics can be improved under this condition by moving the CG aft to the extent possible (within limits). To achieve this, if passenger loading permits, seat passengers so as to occupy cabin seats from rear to front.

- Operate stabilizer to a slightly nose-up position to restore elevator movement in both directions. A slight forward force on the control column will be required to maintain level flight.

- Make a long, straight landing approach. Lower flaps to 45° and operate stabilizer as necessary to maintain desired attitude. When speed is reduced to about REF, trim stabilizer out to zero elevator stick force. Then, by reference to TPI indicator, apply 2-1/2° of nose-up stabilizer. A forward force of 10 to 30 pounds on the control column will then be required to counteract the tendency of the airplane to change attitude.

- Aim the airplane onto the runway in as flat an attitude as possible, guarding against the nose wheel sriking the ground first. At point of flare-out, relax forward pressure on the control column.

MACH TRIM SYSTEM

If mach trim system functions abnormally or is otherwise inoperative:

Mach Trim Switch - OFF.

Airspeed - MAXIMUM MACH .72.

STALL PROTECTION

HEATER MONITORING

Stall Warning Sensor Heat Failure Light ON: NO ACTION. If in icing conditions, TRIP appropriate stall warning circuit breaker:

- For #1 system C/B #370, Panel P (F/O's Side Panel)
- For #2 system C/B #351, Panel P (F/O's Side Panel)

Stall Push Sensor Heat Failure Light ON: NO ACTION. If in icing conditions, TRIP appropriate stall push circuit breaker:

- For #1 system C/B #177, Panel B-4 (behind left cockpit chair)
- For #2 system C/B #165, Panel B-3 (behind left cockpit chair)

GENERAL FAILURES

Providing aircraft attitude and airspeed are NORMAL:

Stickshaker Operating: TRIP appropriate stall warning circuit breaker.

- For #1 system C/B #370, Panel P (F/O's Side Panel)
- For #2 system C/B #351, Panel P (F/O's Side Panel)

Pusher Fail (RED) and System (RED) Lights ON: PULL dump valve lever.

Stick Moving Foward, Not Following Stickshaker: PULL dump valve lever.

AUTOPILOT FAILURE TO ENGAGE

Check the following:

Autopilot Master Switch - ON.

Turn Controller - CENTER DETENT.

Mode Selector - MANUAL.

Both Vertical Gyros - OPERATIVE.

AUTOPILOT AUTOMATIC DISENGAGEMENT INFLIGHT

Establish manual control of the aircraft and press the disengage button on either control wheel. Wait 3 seconds and attempt to re-engage.

If unable to engage or re-engage the autopilot:

Master Switch - OFF.

AUTOPILOT EMERGENCY DISENGAGEMENT

If unable to disengage the autopilot by normal means, either of the following may be used to regain manual control of the aircraft:

Autopilot Master Switch - OFF.

-or-

Autopilot C/B's (#437 and #448 on Right-Hand Strip Panel) - PULL.

ALTITUDE LOSSES CAUSED BY MALFUNCTIONING

The autopilot has been designed to disconnect automatically with any hardover malfunction which might cause a significant loss of altitude. However, some malfunctions might cause small deviations from the correct altitude or flight path.

ENROUTE

If a slow malfunction of the air data system occurs and 5 seconds elapse before the autopilot is disengaged, not more than 500 feet will be lost during malfunction and recovery under any conditions.

APPROACH

With failure of glideslope input signal to the autopilot when uncorrected for 2 seconds, the airplane will not deviate more than 20 feet below the correct glideslope. This assumes the malfunction occurs close to the minimum break-off altitude.

NOTE: In both cases, auto-trim has been assumed to be serviceable.

RUDDER CONTROL MALFUNCTION

Should any abnormality occur in the rudder control system in flight:

Airspeed - REDUCE. Reduce airspeed to turbulent air penetration speed as soon as practicable and avoid known areas of turbulence.

If problem occurs in flight while engaged in turbulent air, avoid any large rudder inputs.

SECTION 1-308

FLIGHT INSTRUMENTS

SUBJECT	PAGE NO.
GPWS FALSE GLIDESLOPE WARNING	1-308-1
GPWS FALSE TERRAIN WARNING	1-308-2
LOSS OF RADOME/AIRSPEED CONTROL	1-308-3
- General Characteristics	1-308-3
- Procedures	1-308-3

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GPWS FALSE GLIDESLOPE WARNING

Spurious glideslope signals are often present during a backcourse or circling approach that may trigger the "Glideslope" advisory. To preclude such warnings:

- On an ILS approach to a circle for a landing on the reciprocal runway or another runway, select the left ILS front/back switch to BACK after the circle is initiated.
- On a backcourse approach, select the left ILS front/back switch to BACK before the approach is initiated.

NOTE: The GPWS inhibit switch should only be activated for a planned deviation from the glideslope (as in the possible case of a no flap landing) or a GPWS Mode 5 problem.

GPWS FALSE TERRAIN WARNING

Should the GPWS malfunction and produce continuous warnings and it is immediately determined that no dangerous situation exists, the system may be deactivated by placing the GPWS control switch to INHIBIT.

If a warning would be activated when landing with the flap position less than landing configuration (single-engine landing), the GPWS control switch is placed to the FLAP OVRD position on approach. All inputs except for the flap logic would remain operational.

If a warning would be activated when landing with the gear lever in other than the DOWN position, the GPWS control switch is placed to INHIBIT.

Approaches with unusual terrain, such as descending on final with the terrain rising upward toward the runway level, may momentarily cause GPWS warnings.

With an inflight failure or malfunction of the GPWS system, the flight or series of flights may continue, but may not depart a station where repairs can be made.

NOTE: Whenever the GPWS is deactivated, an entry which includes the date and time of deactivation must be made in the aircraft logbook.

LOSS OF RADOME/AIRSPEED CONTROL

GENERAL CHARACTERISTICS

Loss of radome results in the following general characteristics:

Airspeed Indications

Radome loss causes aerodynamic interference with the pitot head and static ports, resulting in apparent drop in airspeed of about 20 knots when using the normal static source. This effect can be greatly reduced by using the alternate static source. Assuming that the pitot/static ports are not damaged, and alternate static source is selected, the airspeed indicators generally "under-read" (actual airspeed will be 5 to 10 knots higher than indicated airspeed).

Pitot heads are very sensitive to sideslip; pitot on windward side will recover to very near its normal value if airplane is sideslipped; whereas, pitot on leeward side will deteriorate rapidly. Indicated airspeed (IAS) readings will probably oscillate between ±10 and ±20 knots, the amplitude of the oscillations increasing as airspeed is reduced.

Altimeter, Vertical Speed, and Cabin Altimeter Indications

Radome loss will probably not affect static pressure for these units. Their indications should be reliable.

Mach Trim

If flying manually or if autopilot disengages when cruising above M.68/9,600 feet, radome loss will probably result in a slight tendency for airplane to pitch nose-down due to loss of pitot pressure to Mach trim system. Should this occur, restrain Mach trim hand wheel or apply nose-up elevator until Mach trim action ceases.

Airplane Performance

Radome loss produces only a small decrease in performance capability. It should have no effect on stall speeds or stickshaker speeds assuming of course that angle of attack sensors are not damaged. However, considerable buffeting may occur.

Noise

Radome loss will, of course, increase cockpit noise level, particularly at higher airspeeds.

PROCEDURES

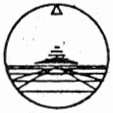
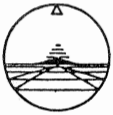
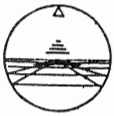
Use the following charts to determine target HDI attitude and power settings for various conditions and airplane configurations. Charts are applicable to all gross weights. Autopilot, including altitude hold and coupler, remains completely operative and can be used if desired. Place Captain's and First Officer's ASI and air data selectors to ALTERNATE. Airspeed may be unreliable and therefore, should only be used as supplementary information in addition to HDI attitude and power settings specified on the charts. A more accurate airspeed indication may be obtained by momentarily sideslipping the airplane about 5° and reading Mach/airspeed indicator on windward side.

CAUTION: To avoid excessive loads on airframe, airplane should not be sideslipped at speeds above 250 KIAS.

(cont'd.)

LOSS OF RADOME/AIRSPEED CONTROL (cont'd.)

PROCEDURES (cont'd.)

CLIMB Use chart power setting and establish chart attitude, monitoring HDI attitude and vertical speed indication. Approximate chart rate of climb should result.	FLY: 8° - 10° NOSE-UP SET: 94% N2 TO PRODUCE: 250 KIAS (about 2,000 FPM climb) 
CRUISE Establish approximate chart power setting and maintain 0 FPM rate of climb until reaching chart HDI attitude, then readjust power as necessary to maintain attitude and altitude. Thereafter, fly HDI attitude closely to prevent large speed excursions.	FLY: 2° NOSE-UP SET: FUEL FLOW: 2,600 PPH (about 90% N2) TO PRODUCE: 280 KIAS LEVEL FLIGHT
DESCENT Use chart attitude and low or idle thrust, monitoring HDI attitude and vertical speed indications. Extend flaps only after stabilizing in level flight with proper HDI attitude and power setting.	FLY: 2° NOSE-DOWN SET: IDLE POWER TO PRODUCE: 250 KIAS (about 2,000 FPM descent)
MANEUVER - CLEAN FLY: 7° NOSE-UP SET: FUEL FLOW: 2,000 PPH TO PRODUCE: 200 KIAS LEVEL FLIGHT 	**MANEUVER - 18° FLAPS** FLY: 5° NOSE-UP SET: FUEL FLOW: 2,300 PPH (about 88% N2) TO PRODUCE: 150 KIAS LEVEL FLIGHT 
FINAL APPROACH **(45° FLAPS, GEAR DOWN)** Make landing on runway having operative glideslope, if practicable. Where glideslopse is available, maintain chart attitude and adjust power to maintain position on glideslope. Where no glideslope is available, maintain chart attitude and adjust power to maintain chart descent rate.	FLY: 0° - 1/2°° NOSE-UP SET: FUEL FLOW: 2,900 PPH (about 88% N2) TO PRODUCE: REF + 10 (about 700 FPM descent) 

SECTION 1-309

FUEL

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BACKING PUMP FAILURE

LP Warning Light - ON.

Boost Pumps - ALL ON. If quantity gauges indicate a substantial fuel loss, shut affected engine down immediately. Guard engine for fire for a 10-minute period.

A backing pump failure causes an engine LP warning light to illuminate.

If excessive fuel consumption, as indicated by tank contents gauge (not fuel flow), and possible loss of HP RPM:

Both HP & LP Fuel Valves (on the Affected Side) - CLOSE IMMEDIATELY. Monitor the Zone 1 fire indicating system for 10 minutes after shutdown.

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BOOST PUMP FAILURE (ONE)

If both boost pumps in one tank are ON:

Normally, there will be no cockpit indication if one pump fails. The probability of a bad boost pump's circuit breaker (located on center strip panel in companionway, left side) popping is remote; but if it does, proceed as follows:

Failed Pump - OFF.

CAUTION: DO NOT RESET BOOST PUMP C/B IN FLIGHT.

If only one boost pump is ON, or if one has already failed and operative pump is subsequently turned OFF:

Boost pump failure will be indicated by illumination of BOOSTER PUMP LP light. Proceed as follows:

Good Pump - ON.

Failed Pump - OFF.

NOTE: Unusable fuel increases with extreme altitudes.

CAUTION: DO NOT RESET BOOST PUMP C/B IN FLIGHT.

BOOST PUMP FAILURE (TWO)

Fuel Crossfeed - CLOSED.

Altitude - REDUCE. Maximum engine power may not be available at any altitude, especially at high altitudes.

Engine Power - AVOID MAXIMUM POWER. Maximum power and extreme nose high attitudes should be avoided at any altitude with low fuel quantities. Descend aircraft to low altitude and attempt to maintain level deck angles.

CAUTION: DO NOT RESET BOOST PUMP C/B IN FLIGHT.

DEPLETED FUEL

At 750 lbs. per tank of fuel, consider the usable fuel in that tank to be depleted to the point that a Balked Landing and VFR circuit of the landing pattern will exhaust all usable fuel from that tank.

This is a conservative value that includes the worst case system indication errors. An IMMEDIATE LANDING is required by this condition. DO NOT execute a go-around, unless an extreme emergency condition requires it.

ENGINE FAILURE

Fuel symmetry should be sensibly maintained by fuel transfer, opening the crossfeed valve, and using the booster pumps as required.

FUEL LEAKAGE

Use fuel at the maximum rate from the tank in the affected wing by:

Fuel Transfer - DISCONTINUE to the affected tank.

Both Pumps (Affected Wing) - ON.

Crossfeed Valve - OPEN.

Both Pumps (Other Tank) - OFF, until they are required.

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LOW FUEL CONTENTS

High nose-up attitudes in excess of 10° must not be sustained for more than 30 seconds with fuel quantities less than 1,500 lbs. in any tank as engine flame-out can occur.

During balked landing, with less than 1,500 lbs. in either wing tank, the LP lights may illuminate during the climb segment if the rear pump becomes inoperative. This may be ignored.

When quantity in either wing tank has dropped to 750 lbs., switch ON all booster pumps and OPEN the crossfeed valve. Changes in aircraft attitude should be made as smoothly as possible and extreme attitudes must be avoided.

TRANSFER LP LIGHT ON

Other Transfer Pump - ON. If both transfer pumps are ON, there will normally be no indication of a single pump failure. Normally, only one transfer pump is needed to meet transfer requirements. However, due to characteristics of the fuel transfer system, it is sometimes necessary to operate both transfer pumps to extinguish the transfer LP light when center tank fuel quantity is low. Use of both transfer pumps, in this case, is considered normal and should not be entered in the log book as a discrepancy. However, if desired, an "Info to Maintenance" entry may be made.

The probability of a bad transfer pump's circuit breaker popping is remote, but if it does, proceed as follows:

Good Transfer Pump - ON.

Failed Transfer Pump - OFF.

CAUTION: DO NOT RESET THE C/B IN FLIGHT.

TRANSFER VALVE INOPERATIVE (CLOSED)

Feed center tank fuel or long range tank fuel (if installed) to tank with inoperative valve.

Feed that wing tank to both engines until center tank is empty.

NOTE: Refer to Chapter 9 - AIRCRAFT FUEL for FEEDING ONE WING TANK TO BOTH ENGINES procedure.

LONG RANGE FUEL SYSTEM (IF INSTALLED)

In the event of inability to transfer fuel from the fuselage fuel tanks due to failure of any system components, the airplane is airworthy and may be landed safely with fuel in the fuselage tanks.

FUSELAGE TANK TRANSFER PUMP FAILURE (ONE)

Failed Pump - OFF.

Good Pump - ON.

Due to the characteristics of the fuselage tank (long range fuel) transfer system, it is sometimes necessary to operate both fuselage tank transfer pumps to extinguish the fuselage tank transfer pump LP light, especially when the associated fuselage tank fuel quantity is low.

In the case of one fuselage tank transfer pump inoperative, the associated fuselage tank transfer pump LP light may be illuminated. Fuel transfer should be normal.

If one fuselage tank transfer pump is inoperative, the unusable fuel may increase in the associated tank.

Supplied by Jeppesen Sanderson

FUSELAGE TANK SHUTOFF VALVE WILL NOT CLOSE

FORWARD FUSELAGE TANK VALVE WILL NOT CLOSE AFTER FUEL TRANSFER

Subsequent transfer from the center tank may be at low pressure and intermittent.

Continue with normal fuel transfer procedures.

AFT FUSELAGE TANK VALVE WILL NOT CLOSE AFTER FUEL TRANSFER

This will not affect fuel transfer from the center fuselage tank.

Fuselage Tank Forward Transfer Pumps (One or Both) - ON.

CENTER FUSELAGE TANK VALVE WILL NOT CLOSE AFTER FUEL TRANSFER

Fuselage Tank Forward Transfer Pumps - BOTH OFF.

Continue with normal center tank fuel transfer procedures.

FUSELAGE TANK SHUTOFF VALVE WILL NOT OPEN

FORWARD FUSELAGE TANK VALVE WILL NOT OPEN

If zero fuel CG is 12.35 or more IU (index units) aft of forward CG limit:

Transfer from AFT or CENTER tanks by normal procedures.

If zero fuel CG is less than 12.35 IU, but more than 8.40 IU aft of forward CG limit:

Transfer all fuel from CENTER tank before transferring from AFT tank.

If zero fuel CG is less than 8.40 IU aft of forward CG limit:

Transfer fuel from CENTER tank, but DO NOT transfer fuel from AFT tank unless load can be adjusted in flight to make zero fuel CG 8.40 IU or more aft of forward CG limit.

AFT FUSELAGE TANK VALVE WILL NOT OPEN

If zero fuel CG is 2.00 or more IU forward of aft CG limit:

Transfer from the CENTER tank by normal procedures.

If zero fuel CG is less than 2.00 IU forward of aft of forward CG limit:

DO NOT transfer fuel from CENTER tank unless load can be adjusted in flight to make zero fuel CG 2.00 IU or more forward of aft CG limit.

CENTER FUSELAGE TANK VALVE WILL NOT OPEN

After FORWARD and AFT fuselage tanks have been transferred in normal order:

Fuselage Tank Shutoff Valves (All 3) - CLOSED.

All Fuselage Tank Transfer Pumps - OFF.

Continue with normal center tank transfer procedures.

FUEL JETTISONING

GENERAL

Fuel may be jettisoned at any speed and altitude within the normal flight envelope with the aircraft in any normal attitude. However, in other than shallow climbs and descents, the automatic cutoff will not necessarily operate at the correct levels. The flaps must not be extended more than 18°.

Dump rates can normally be computed (all jettison valves open) at 1,350 lbs./min. total. Wing tanks terminate dumping automatically at 2,500 lbs. each. The center tank can be emptied and the fuselage tanks (long range fuel, if installed) can be emptied to their unusable fuel level.

Fuel from the wing tanks and center tanks is jettisoned through their respective jettison valves. Fuel may be jettisoned from fuselage fuel tanks (long range fuel, if installed) by transfering fuselage fuel to outer wing tanks by normal procedures, using both fuselage tank transfer pumps.

NORMAL PROCEDURES

If it is not required to jettison fuel from the center tank or any of the fuselage tanks (long range fuel, if installed), the associated transfer pump switches should be set to OFF.

If it is not required to jettison fuel from either wing tank, the jettison valve switch for that tank should be left CLOSED.

Complete the following procedure as required:

Wing Tank Transfer Valves - BOTH OPEN.

Forward Fuselage Tank Shutoff Valve - OPEN, if fuel to be jettisoned from tank.

Fuselage Tank Forward Transfer Pumps - ON.

All Boost and Transfer Pump Switches (except Fuselage Tank Aft Transfer Pumps) - ON.

Jettison Panel Cover - OPEN.

Jettison Gang Bar - PULL DOWN.

Jettison Valve Indicators - IN-LINE.

Tank Quantity Gauges - MONITOR.

NOTE: Wing and center tank dump rates exceed fuselage tank transfer rates. In some cases, it may be necessary to terminate jettisoning if more fuel is required in the wing tanks than the automatic cutoff provides, until fuel is transferred from the fuselage tanks to the wing tanks. In any case, burnoff will help.

(cont'd.)

FUEL JETTISONING (cont'd.)

NORMAL PROCEDURES (cont'd.)

When FORWARD FUSELAGE TANK is EMPTY:

Forward Fuselage Tank Shutoff Valve - CLOSE.

Fuselage Tank Forward Transfer Pumps - BOTH OFF.

Aft Fuselage Tank Shutoff Valve - OPEN.

Fuselage Tank Aft Transfer Pumps - BOTH ON.

When AFT FUSELAGE TANK is EMPTY:

Aft Fuselage Tank Shutoff Valve - CLOSE.

Fuselage Tank Aft Transfer Pumps - BOTH OFF.

Center Fuselage Tank Shutoff Valve - OPEN.

Fuselage Tank Forward Transfer Pumps - BOTH ON.

When CENTER FUSELAGE TANK is EMPTY:

Center Fuselage Tank Shutoff Valve - CLOSE.

Fuselage Tank Transfer Pumps - ALL OFF.

Jettison center and wing fuel as required.

AFTER JETTISONING

Jettison Valve Switches - CLOSED.

Jettison Valve Indicators - CROSS-LINE.

Jettison Panel Cover - CLOSE.

Boost and Transfer Pumps - AS REQUIRED.

ABNORMAL PROCEDURES

Boost Pump Failure

If one pump fails, the remaining pump in that tank will continue to jettison fuel at a slower rate. Fuel gauges must be monitored so that asymmetry does not exceed 4,500 lbs. when landing.

Jettison Valve Failure

Open crossfeed valve between tanks and jettison fuel through the other valve.

(cont'd.)

FUEL JETTISONING (cont'd.)

FUEL JETTISON TIMES

There are no structural wing or center fuel quantity limits for landings at weights of 82,000 lbs. or less. Fuel in the long range tanks (if installed) can be included in the zero fuel weight center of gravity.

The following jettison times are based on the LEFT and RIGHT dump valves being OPEN (1,350 lbs./min.) Jettison times approximately double with only one dump valve OPEN (675 lbs./min.).

	TO JETTISON FROM A GROSS WEIGHT OF: (1,000 of lbs.)											
TO A GROSS WEIGHT OF: (lbs.)	87.0	86.0	85.0	84.0	83.0	82.0	81.0	80.0	79.0	78.0	77.0	75.0
	JETTISON TIMES (Minutes and Tenths of Minutes)											
86,000	0.75											
85,000	1.50	0.75										
84,000	2.25	1.50	0.75									
83,000	3.00	2.25	1.50	0.75								
82,000	3.75	3.00	2.25	1.50	0.75							
81,000	4.50	3.75	3.00	2.25	1.50	0.75						
80,000	5.25	4.50	3.75	3.00	2.25	1.50	0.75					
79,000	6.00	5.25	4.50	3.75	3.00	2.25	1.50	0.75				
78,000	6.75	6.00	5.25	4.50	3.75	3.00	2.25	1.50	0.75			
77,000	7.50	6.75	6.00	5.25	4.50	3.75	3.00	2.25	1.50	0.75		
76,000	8.25	7.50	6.75	6.00	5.25	4.50	3.75	3.00	2.25	1.50	0.75	
75,000	9.00	8.25	7.50	6.75	6.00	5.25	4.50	3.75	3.00	2.25	1.50	0.75
74,000	9.75	9.00	8.25	7.50	6.75	6.00	5.25	4.50	3.75	3.00	2.25	1.50
73,000	10.5	9.75	9.00	8.25	7.50	6.75	6.00	5.25	4.50	3.75	3.00	2.25
72,000	11.3	10.5	9.75	9.00	8.25	7.50	6.75	6.00	5.25	4.50	3.75	3.00
71,000	12.0	11.3	10.5	9.75	9.00	8.25	7.50	6.75	6.00	5.25	4.50	3.75
70,000	12.7	12.0	11.3	10.5	9.75	9.00	8.25	7.50	6.75	6.00	5.25	4.50

CAUTION: Do not fly circular pattern while jettisoning fuel as this may return airplane to "vapor zone" of previously jettisoned fuel. "Vapor Zone" is defined as airspace at least 1,000 feet above, 2,000 feet below, 5 NM horizontally behind, and 1/2-mile either side of an airplane jettisoning fuel.

DO NOT extend flaps greater than 18° while jettisoning fuel.

SECTION 1-310

HYDRAULICS

SUBJECT	PAGE NO.
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AUXILIARY HYDRAULIC PUMP OVERHEAT LIGHT ON	1-310-8
ENGINE PUMP FAIL LIGHT ON	1-310-1
HYDRAULIC CUTOFF LEVER LIGHT ON	1-310-15
HYDRAULIC FLUID QUANTITY DECREASING	1-310-4
HYDRAULIC SYSTEM OVERHEAT LIGHT REMAINS ON FOR EXTENDED PERIOD	1-310-9
LANDING WITH HYDRAULIC FAILURE - NO. 1 SYSTEM INOP	1-310-10
LANDING WITH HYDRAULIC FAILURE - NO. 2 SYSTEM INOP	1-310-11
LANDING WITH HYDRAULIC FAILURE - BOTH SYSTEMS INOP	1-310-12
LOW FLUID QUANTITY SYSTEM NO. 1	1-310-5
LOW FLUID QUANTITY SYSTEM NO. 2	1-310-6
LOW HYDRAULIC SYSTEM PRESSURE	1-310-3
RESTRICTION TABLES FOR MALFUNCTIONING EQUIPMENT	1-310-13
SYSTEM COMPONENTS AVAILABILITY TABLE	1-310-14
SYSTEM OVERHEAT LIGHT ON	1-310-7

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ENGINE PUMP FAIL LIGHT ON

Pressure and Quantity - CHECK.

If pressure and quantity are NORMAL for pumps on affected side:

Engine Pump - OFF.

Auxiliary Pump - ON.

Reservoir pressurization failure is indicated. Turning OFF the engine pump will extinguish the fail light.

If pressure is LOW and quantity is NORMAL for pumps on affected side:

Engine Pump - OFF.

Auxiliary Pump - ON.

Engine pump failure is indicated.

If quantity is LOW:

Engine Pump & Auxiliary Pump - BOTH OFF. Refer to abnormal procedure LOW FLUID QUANTITY (SYS #1 or SYS #2) in this section, as required.

AUXILIARY PUMP FAIL LIGHT ON

Quantity - CHECK.

If quantity is NORMAL for pumps on affected side:

Auxiliary Pump - OFF

Engine Pump - ON, if normal.

If quantity is LOW:

Engine Pump & Auxiliary Pump - BOTH OFF. Refer to abnormal procedure LOW FLUID QUANTITY (SYS #1 or SYS #2) in this section, as required.

LOW HYDRAULIC SYSTEM PRESSURE

A system low pressure indication could be the result of a pump failure or a fluid leak.

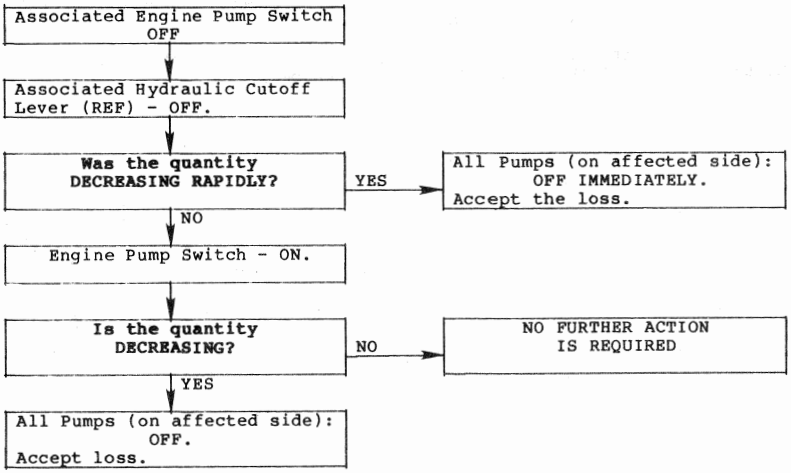
In the case of a pump failure, the associated pump fail light should illuminate. Refer to the corresponding abnormal procedure HYDRAULIC PUMP FAIL LIGHT ON in this section.

If a decrease in fluid quantity is indicated, refer to abnormal procedure HYDRAULIC FLUID QUANTITY DECREASING in this section.

Supplied by Jeppesen Sanderson

HYDRAULIC FLUID QUANTITY DECREASING

If the fluid quantity indication for one system decreases through the YELLOW and towards the RED sector:


Associated Engine Pump Switch OFF
Associated Hydraulic Cutoff Lever (REF) - OFF.
Was the quantity DECREASING RAPIDLY?
YES
All Pumps (on affected side): OFF IMMEDIATELY. Accept the loss.
NO
Engine Pump Switch - ON.
Is the quantity DECREASING?
NO
NO FURTHER ACTION IS REQUIRED
YES
All Pumps (on affected side): OFF. Accept loss.

NOTE: If it becomes essential to attempt to pressurize the system and the quantity indicates in the RED sector, sufficient fluid quantity is available for the auxiliary pump ONLY in the No. 1 system and for the DC pump ONLY in the No. 2 system.

LOW FLUID QUANTITY SYSTEM NO. 1

Turn OFF engine pump and auxiliary pump, unless system is urgently needed. Otherwise, turn one pump ON during final approach and landing.

NOTE: With an indicated fluid quantity above 1.0 gallons, fluid is available to both pumps.

Below this quantity, only the auxiliary pump will receive fluid.

LOW FLUID QUANTITY SYSTEM NO. 2

Turn OFF all pumps, unless system is urgently needed. Otherwise, turn one pump ON during final approach and landing.

NOTE: With an indicated fluid quantity above 1.6 gallons, fluid is available to all pumps.

With an indicated fluid quantity between approximately 1.3 gallons (bottom of the YELLOW sector) and 1.6 gallons, fluid is available to the auxiliary AC and DC pumps only.

Fluid for the DC pump is available with any indicated quantity for the No. 2 reservoir.

Fluid quantity for the emergency reservoir is not shown on the quantity indicator.

SYSTEM OVERHEAT LIGHT ON

INDICATES: Fluid overheat in main reservoir.

Pumps (on Affected Side) - BOTH OFF.

If the overheat light EXTINGUISHES:

Try to operate system with auxiliary pump. It may require 15 to 20 minutes for the light to extinguish.

If the overheat light REMAINS ILLUMINATED or ILLUMINATES AGAIN:

Pumps (on Affected Side) - BOTH OFF, unless the system is urgently needed, in which case, use only one pump.

NOTE: Refer to abnormal procedure HYDRAULIC SYSTEM OVERHEAT LIGHT REMAINS ON FOR EXTENDED PERIOD in this section.

Supplied by Jeppesen Sanderson

AUXILIARY HYDRAULIC PUMP OVERHEAT LIGHT ON

INDICATES: Motor Overheat.

Pump (on Affected Side) - OFF. Do not switch the pump back ON unless engine pump subsequently fails and the auxiliary pump is urgently needed.

NOTE: The light will extinguish when the pump is switched OFF; however, the light will immediately illuminate again if the pump is subsequently switched ON and thermal switch in pump motor has not cooled down.

Warning light will reset when thermal switch cools down. Pump will operate when selected ON, even with the warning light ON.

HYDRAULIC SYSTEM OVERHEAT LIGHT REMAINS ON FOR EXTENDED PERIOD

If pressure remains at 3,000 PSI:

Engine Pump - OFF.

LP Fuel Valve C/B (for Affected Side) - TRIP. Pull LP fuel valve C/B for affected side (#366 left LP or #368 right LP) located on the First Officer's circuit breaker console. This will allow the respective fire control handle to be pulled. The engine will continue to run.

Fire Control Handle (for Affected Side) - PULL. This will shut hydraulic fluid off to the engine-driven pump and correct overheat situation. This will also cut off air from that engine. If anti-ice is not in use, open crossfeed valve to use both air conditioning packs.

Auxiliary Hydraulic Pump - ON. When system overheat light extinguishes, select respective system auxiliary hydraulic pump ON and use system normally.

CAUTION: DO NOT RESET the LP fuel valve C/B while fire control handle is pulled or engine flame-out will occur.

If fire subsequently occurs in affected engine, it will be necessary to RESET the LP fuel valve C/B before completing the Engine Fire checklist.

LANDING WITH HYDRAULIC FAILURE - NO. 1 SYSTEM INOPERATIVE

LANDING GEAR FREE FALL:

Airspeed - REDUCE. Slow the aircraft to 230 KIAS maximum, slower if possible.

Gear - FREE FALL. Place gear handle to DOWN position to assure gear has down signal, if hydraulic pressure should return for any reason. Raise access panel on right lower console, right of First Officer. Pull up on free fall handle and a cable-operated free fall mechanism releases the nose gear uplock and the main gear door uplocks and allows all three gear to fall and lock down under their own weight. Main gear doors will hang open and will strike runway surface during landing; however, each has a reinforced metal skid provided for sliding on runway. Do not taxi other than possibly to clear runway until mechanic locks doors up and installs gear pins.

CAUTION: Do not restow the free fall handle.

Gear Indicators - 3 GREEN, 1 RED. Three green lights will indicate all three gear are down and locked. Red light will be illuminated to indicate both main gear doors are not locked closed.

NOTE: This light will also indicate red if gear and handle are not in same position.

Standby Steering Switch - ON, during final approach. Limited nosewheel steering is available from the standby steering accumulator. This will provide approximately 220° of steering which is ample for landing and clearing runway, but will not provide for extended taxiing. Amber light indicates low pressure in nose steering accumulator (below 2,000 PSI). Steer with brakes, if necessary. Rudder fine steering is not dependable because No. 1 hydraulic system pressure to connect the rudder pedals to the nosewheel steering control cables is not available.

GPWS - DEACTIVATE. Deactivate GPWS before landing with flaps less than 26° (FLAP OVERRIDE) or with gear handle unable to be selected DOWN (INHIBIT).

NOTE: Refer to RESTRICTIONS FOR MALFUNCTIONING EQUIPMENT and SYSTEMS COMPONENTS AVAILABILITY tables in this section for list of operative and/or inoperative equipment.

LANDING WITH HYDRAULIC FAILURE - NO. 2 SYSTEM INOPERATIVE

Brake Accumulators (Top off with DC pump) - CHECK. Dual brake accumulator pressure indicator indicates brake pressure available from hand and foot brake accumulators. Transmitters for indicator are located on preload side of accumulators and show preload pressure when normal hydraulic pressure is exhausted. Accumulator indicators should read system pressure. If they are low, top off by holding DC pump to the UP spring-loaded position until pressure is up.

Available with Full Accumulators - ONE ANTI-SKID AND SIX HAND BRAKE APPLICATIONS. After landing, hold foot pressure on brakes for one full anti-skid application. DO NOT PUMP. Then with caution, change to handbrake. Handbrake is extremely sensitive and has no anti-skid protection.

NOTE: Refer to RESTRICTIONS FOR MALFUNCTIONING EQUIPMENT and SYSTEMS COMPONENTS AVAILABILITY tables in this section for list of operative and/or inoperative equipment.

LANDING WITH HYDRAULIC FAILURE - BOTH SYSTEMS INOPERATIVE

Airspeed - MAXIMUM 270 KIAS OR MACH .72.

Flight Controls - REVERT TO MANUAL.

Elevator Power - RESTORE. Elevator power can be restored from the emergency elevator system. Before restoring elevator power, airplane should be brought as near an in-trim condition as possible. If speed is near Mmo at the time of hydraulic failure, there will be a nose-up trim change. Trim will be restored by reducing speed. At lower speeds, trim should be restored by using elevator emergency trim tab.

After establishing near in-trim conditions, the slower the better, place elevator emergency switch to EMERG position to provide powered elevator. The emergency elevator indicator lights, adjacent to the left and right master caution panel, should flash. Stick forces will be lighter than usual, particularly at aft CG. Stick force increases steeply for large elevator deflection. Refer to Chapter 1 - EMERGENCY for LANDING WITH EMERGENCY ELEVATOR POWER.

GPWS - FLAP OVERRIDE.

NOTE: Refer to RESTRICTIONS FOR MALFUNCTIONING EQUIPMENT and SYSTEMS COMPONENTS AVAILABILITY tables in this section for list of operative and/or inoperative equipment.

RESTRICTION TABLES FOR MALFUNCTIONING EQUIPMENT

MALFUNCTIONING EQUIPMENT	INCREASE LANDING DISTANCE BY
One Set of Spoilers	10%
Both Sets of Spoilers	20%
Lift Dumpers	10%
Anti-Skid	10%

ABNORMAL FLIGHT CONTROLS	MAXIMUM RECOMMENDED CROSSWIND COMPONENT
One Set of Spoilers	25 knots
Both Sets of Spoilers	15 knots
Emergency or Manual Elevator	10 knots
Manual Rudder	10 knots

SYSTEM COMPONENTS AVAILABILITY TABLE

COMPONENT	HYD SYSTEM #1 INOP	HYD SYSTEM #2 INOP	BOTH HYD SYSTEM #1 & #2 INOP
LANDING GEAR	Free Fall	Okay	Free Fall
NOSEWHEEL STEERING	Select STBY ON	Okay	Select STBY ON
WHEEL BRAKES	Okay	Top off accumulator with DC pump. One anti-skid and six hand brake applications will be available.	
FLAPS	Okay	Okay	Use Emergency Flaps
OUTBOARD SPOILERS	Inoperative	Okay	Inoperative
INBOARD SPOILERS	Okay	Inoperative	Inoperative
REVERSERS	No effect (Pneumatic)		
STABILIZER	Okay	Okay	Inoperative
ELEVATOR	Okay	Okay	Select Emergency Elevator
RUDDER	Okay	Okay	Reverts to Manual
WINDSHIELD WIPERS	F/O's INOP	Captain's available from the DC Pump.	
STAIRS	Okay	Can be operated manually.	

HYDRAULIC CUTOFF LEVER LIGHT ON

Hydraulic Flight Control Cutoff Lever - OFF. When light illuminates, pull respective lever to full AFT position to close power control valves and extinguish light. The auto-isolate valve for elevator or rudder closes automatically. The lever should remain in the OFF position for the remainder of the flight.

Light illumination in the head of the lever indicates a mechanical malfunction of a control valve of a flight control hydraulic actuator; therefore, the need for closing the power control valve (flaps, rudder, or elevator).

NOTE: With No. 1 hydraulic cutoff lever in the OFF position, only the outboard spoilers and #1 TPI control valve are lost.

With No. 2 hydraulic cutoff lever in the OFF position, only the inboard spoilers, #2 TPI control valve, and the series yaw damper are lost. Use autopilot yaw damper, if desired.

Hydraulic cutoff levers have no effect on lift dumper operation.

CAUTION: With the loss of either set of spoilers, consideration should be given to the inability of the airplane to obtain a maximum rate of descent, if an emergency descent is required from a high altitude.

If both sets of spoilers are inoperative, a descent to a lower altitude should be considered. Maximum rates of descent cannot be achieved, if required.

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SECTION 1-311

ICE & RAIN PROTECTION

SUBJECT	PAGE NO.
ANTI-ICING WITH ONE ENGINE OR ONE PNEUMATIC SYSTEM INOP	1-311-1
ENGINE ANTI-ICING AIR PRESSURE LOW	1-311-2
ENGINE ANTI-ICING AIR PRESSURE TOO HIGH	1-311-3
PITOT HEAT GAUGE INDICATES ABNORMAL AMPERAGE AND/OR PITOT HEAT MONITOR LIGHT ON	1-311-4
PITOT OR SAT/TAS PROBE HEATER INOP	1-311-5

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ANTI-ICING WITH ONE ENGINE OR ONE PNEUMATIC SYSTEM INOP

Air Isolation Valve (Inoperative Side): CLOSE.

Crossfeed Valve - CLOSED. DO NOT open the crossfeed valve.

Anti-Icing Valve (Affected Side) - CLOSE. Maintain 72% N2 RPM or flight IDLE, whichever is greater during descent.

If the No. 1 air system is the problem and operating at 17,000 feet or less, the APU can be used for the No. 1 air conditioning pack and the No. 2 system for anti-icing and air conditioning, if necessary. Normally, the APU is not to be used for anti-icing.

If necessary to execute a go-around, turn OFF airframe anti-icing so that maximum power can be utilized. In this case, airframe anti-icing should remain OFF until a positive rate of climb is established and the landing gear is retracted.

Except in an emergency, APU bleed is not normally used for airframe anti-icing. This does not include pre-takeoff checks and preheat. If the use of APU bleed becomes necessary, accomplish the following:

If both pneumatic system air sources are inoperative, the APU may be used for surface anti-icing. However, to preclude exceeding the APU's capability, both air conditioning master valves should be closed. This will necessitate descent to a "habitable" non-pressurized altitude and the APU electrical load, if any, should be reduced to the extent possible.

If anti-icing temperature or pressure is inadequate, anti-ice wing and tail separately. In this case, however, favor wing anti-icing over tail anti-icing to prevent ice formation on wing and shedding into engines.

ENGINE ANTI-ICING AIR PRESSURE LOW

For some flight conditions, engine anti-icing air pressure may be quite low. However, if both gauges are reading about the same, within 15 PSI of each other, there is no reason to suspect valve malfunction.

Under normal cruise conditions, the anti-icing pressure should be at least 30 PSI. If a malfunction is suspected, advance the throttle. As RPM increases, the anti-icing air pressure should remain about the same or may increase slightly; then at higher RPM, it may begin to drop off.

ENGINE ANTI-ICE PRESSURE TOO HIGH

Pressure should never be permitted to exceed 60 PSI. The anti-icing valves normally maintain a pressure of about 43 PSI to 55 PSI. If necessary, throttle back to avoid exceeding 60 PSI; then, trip anti-ice valve circuit breakers, one at a time, to isolate faulty valve.

Engine Anti-Ice Circuit Breakers:

- Engine No. 1: Left Hand -- #171, Panel B-3*
  Right Hand - #216, Panel B-4*

- Engine No. 2: Left Hand -- #172, Panel B-3*
  Right Hand - #217, Panel B-4*

*Panels B-3 and B-4 are located behind the left cockpit chair.

PITOT HEAT GAUGE INDICATES ABNORMAL AMPERAGE AND/OR PITOT HEAT MONITOR LIGHT ON

If a pitot heat gauge indicates abnormal amperage and/or a pitot heat monitor light is illuminated, do not select associated pitot heater control switch OFF. The switch should remain ON to heat associated stall vane.

NOTE: The left and right pitot heat monitor lights will be illuminated any time the associated pitot is not being heated, pitot heat control switch ON or OFF. If both monitor lights are inoperative, check circuit breaker #180 located on Panel B-4 behind the left cockpit chair.

PITOT OR SAT/TAS PROBE HEATER INOP

If a pitot or SAT/TAS probe heater becomes inoperative, consider loss of equipment.

Loss of heat to the SAT/TAS probe could result in loss of correct SAT/TAS indication and ANS WIND and TAS readouts.

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SECTION 1-312

LANDING GEAR

SUBJECT	PAGE NO.
GEAR DOWN GREEN LIGHTS INOPERATIVE	1-312-2
LANDING GEAR HANDLE WILL NOT RAISE AFTER TAKEOFF	1-312-1
ONE RED GEAR UNSAFE LIGHT & THREE GREEN GEAR LIGHTS ON	1-312-3
THREE GREEN GEAR LIGHTS & ONE RED GEAR UNSAFE LIGHT ON	1-312-3

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LANDING GEAR HANDLE WILL NOT RAISE AFTER TAKEOFF

Landing Gear Lever Lock C/B #115 (Panel B-3 behind left cockpit chair) - CHECK.

Because of the inability to determine that main gear struts are fully extended, do not override the gear handle solenoid and raise the handle, unless for safety of flight and retraction is absolutely essential to reduce airplane drag and improve performance.

Retracting gear with a strut not fully extended could cause structural damage in the wheel well area.

GEAR DOWN GREEN LIGHTS INOPERATIVE

If all three gear down green lights are inoperative:

Landing Gear Warning C/B #203 (Panel B-4) - CHECK.

If unable to RESET:

Use mechanical indicators to check gear down and locked.

If one gear down light inoperative:

Recycle gear.

If unable to get green light ON;

Use mechanical indicators to check gear down and locked.

NOTE: The main gear is safe for landing if 1/2-inch or more of green is protruding above the wing surface. The nose gear is safe for landing if at least 75% of lighted green circle is visible. Otherwise, take appropriate emergency measures against the possibility of gear collapse on touchdown or rollout.

THREE GREEN GEAR LIGHTS & ONE RED GEAR UNSAFE LIGHT ON

Gear Handle - DOWN DETENT.

If gear unsafe light remains illuminated:

Landing Gear - RECYCLE (ONE TIME ONLY).

NOTE: If the gear unsafe light remains illuminated when the three green lights are illuminated, the possible cause is a door(s) not closed and locked. It is permissible to cycle the gear ONE TIME ONLY in an attempt to achieve correct indications, but it should be remembered that three green lights illuminated indicates that the gear is down and locked.

If gear unsafe light still remains illuminated:

Gear Handle - DOWN DETENT.

Free Fall Lever - PULL & LATCH UP.

NOTE: A main gear door, if powered open, may be damaged on landing. If pressure is released by pulling the free fall lever, the door will be free to spring up far enough to lessen the risk of damage.

Standby Steering - ON. There is no restriction on the use of standby steering provided the No. 1 hydraulic system remains serviceable.

CAUTION: Exercise caution on landing and taxiing as main gear door(s) may drag on the ground.

After landing:

Pin all landing gear. DO NOT RESET free fall handle.

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SECTION 1-313

PNEUMATICS

SUBJECT	PAGE NO.
BOTH SYSTEM FAIL LIGHTS	1-313-6
DUCT OVER PRESSURE LIGHT ON	1-313-4
DUCT OVER TEMPERATURE LIGHT ON	1-313-3
MAC VALVE AND SYSTEM FAIL LIGHT ON	1-313-7
ONE SYSTEM FAIL LIGHT ON	1-313-5
ONE SYSTEM FAIL LIGHT ON AND STUB DUCT LIGHT ON	1-313-1

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ONE SYSTEM FAIL LIGHT ON AND STUB DUCT LIGHT ON

INDICATES: Engine Strut Overheat.

Air Crossfeed Valve - CHECK CLOSED.

Isolation Valve (Affected Side) - CLOSE. This will allow the system to be reset.

System Fail Press-to-Reset Button - PRESS. This will extinguish lights and reset warning system.

NOTE: Any area that a leak has occurred alerting the 120°C stub duct sensors will require a short time to cool prior to light extinguishing.

If anti-icing is not in use:

Air Crossfeed Valve - OPEN. If air system No. 1 is the problem and at 17,000 feet or less, use APU air, if available, and carefully monitor warning light.

If anti-icing is in use:

Air Crossfeed Valve - DO NOT OPEN. Close the anti-icing valves on affected side. Maintain 72% N2 RPM or flight idle, whichever is greater, during descent.

If air system No. 1 is the problem and operating at 17,000 feet or less, the APU can be used for No. 1 air conditioning pack, and No. 2 system for anti-icing and air conditioning, if necessary. Leave air crossfeed valve CLOSED. Do not use APU for anti-icing.

If system trips again:

Crossfeed Valve or APU Air Delivery Valve - CLOSE. Do not use system again except for starting. Operate engine on operating side to keep duct pressure at or above 30 PSI.

If system does not trip again:

No further action is necessary except to monitor periodically.

Operations above 25,000 feet are not permitted if only one air conditioning system and/or one air system is operating. Experience has shown stub duct trips occurring at high power settings, such as takeoff and climb, normally will reset at cruise power or reduced power conditions possibly allowing engine bleed air to be reintroduced to stub duct without another trip.

If system fails to reset:

Accept loss.

Stub duct leaks can occur in three different areas around the ducting:

- from engine to isolation valve,
- between isolation valve and PRV, and
- between PRV and fuselage.

(cont'd.)

ONE SYSTEM FAIL LIGHT ON AND STUB DUCT LIGHT ON
(cont'd.)

To determine where leak in the ducting has occurred:

- If it was from the engine to the isolation valve, light will not reset until engine is throttled back to low power setting and maybe not even then.

- If leak in the ducting was between the isolation valve and the PRV, light will reset soon after system shuts down.

- If leak in ducting was between the PRV and the fuselage, light will reset shortly after system shuts down but will likely illuminate again when air crossfeed is opened and other system air is introduced to affected ducting.

DUCT OVER TEMPERATURE LIGHT ON

Attempt one reset of the system as follows:

Air Crossfeed Valve - CHECK CLOSED.

Isolation Valve - CLOSE. Closing isolation valve on affected side will allow system to be reset.

Air Temperature Selector Switch - MAINS 1 & 2. This will provide mains temperature indication when reinstating the system.

System Fail Press-to-Reset Button - PRESS. This will extinguish lights and reset warning system.

Isolation Valve - OPEN. Carefully monitor mains temperature gauge.

If temperature remains normal:

No further action is necessary except for periodic monitoring of system temperature.

If temperature rises above green band or if system trips again:

Isolation Valve - CLOSED.

If anti-icing is not in use:

Air Crossfeed Valve - OPEN. If system No. 1 is the problem and at 17,000 feet or less, use APU air, if available.

If anti-icing is in use:

Air Crossfeed Valve - DO NOT OPEN. Close the anti-icing valves on affected side. Maintain 72% N2 RPM or flight idle, whichever is greater, during descent.

If air system No. 1 is the problem and operating at 17,000 feet or less, the APU can be used for No. 1 air conditioning pack, and system No. 2 for anti-icing and air conditioning, if necessary. Leave air crossfeed valve CLOSED. Do not use APU for anti-icing.

Operations above 25,000 feet are not permitted if only one air conditioning system and/or one air system is available. Reducing engine power to affected side could allow system to be reset. After resetting, monitor mains temperature gauge and adjust power to a setting that will allow mains temperature to remain in green band.

DUCT OVER PRESSURE LIGHT ON

Attempt one reset of the system as follows:

Air Crossfeed Valve - CHECK CLOSED.

Isolation Valve - CLOSE. Closing isolation valve on affected side will allow system to be reset.

System Fail Press-to-Reset Button - PRESS. This will extinguish lights and reset warning system.

Isolation Valve - OPEN. Carefully monitor mains duct pressure gauge.

If duct pressure remains normal:

No further action is necessary except for periodic monitoring.

If duct pressure rises above normal or system trips again:

Isolation Valve - CLOSED.

If anti-icing is not in use:

Air Crossfeed Valve - OPEN. If system No. 1 is the problem and at 17,000 feet or less, use APU air, if available.

If anti-icing is in use:

Air Crossfeed Valve - DO NOT OPEN. Close the anti-icing valves on affected side. Maintain 72% N2 RPM or flight idle, whichever is greater, during descent.

If air system No. 1 is the problem and operating at 17,000 feet or less, the APU can be used for No. 1 air conditioning pack, and system No. 2 for anti-icing and air conditioning, if necessary. Leave air crossfeed valve CLOSED. Do not use APU for anti-icing.

Operations above 25,000 feet are not permitted if only one air conditioning system and/or one air system is available. Reducing engine power to affected side could allow system to be reset. After resetting, monitor duct pressure gauge and adjust power to a level that will allow mains pressure to remain in normal operation range.

ONE SYSTEM FAIL LIGHT ON

The following procedure assumes system has been operating normally with air crossfeed CLOSED. The illumination of only the system fail light for a respective system could indicate a problem in the supplemental trip light circuits. Illumination of the light for a respective system should be accompanied by automatic shut down of the affected system as indicated by loss of duct pressure; but in any case, proceed as follows:

NOTE: The duct over temperature and over pressure supplemental trip lights have no test function.

Air Crossfeed Valve - CHECK CLOSED.

Isolation Valve - CLOSE. Closing the isolation valve on the affected side will allow the system to be reset.

System Fail Press-to-Reset Button - PRESS.

If light extinguishes and system resets:

Indicates the problem was not the 120° stub duct overheat. The problem was caused by either the duct overheat or the duct over pressure within the ducting.

Mains Temperature and Pressure Gauges - MONITOR WHEN SYSTEM IS REINSTATED.

Isolation Valve - OPEN TO REINSTATE. Open isolation valve to reinstate air pressure from the engine.

After reinstatement, if cause of trip can be determined, refer to either DUCT OVER TEMPERATURE LIGHT ON or DUCT OVER PRESSURE LIGHT ON abnormal procedure in this section.

If system does not trip again:

No further action required, except for periodic monitoring.

If system fails to reset:

Refer to STUB DUCT LIGHT ON abnormal procedure in this section.

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BOTH SYSTEM FAIL LIGHTS

If mains pressure is NORMAL:

Crossfeed Valve - CLOSE. Recheck mains pressure normal. If both sides are normal, the problem is a fuselage duct leak.

Isolation Valve - CLOSE ONE. With mains pressure normal, crossfeed closed, this indicates a ruptured fuselage duct. To help choose system No. 1 or system No. 2, check to see if either mains pressure is lower or either P-7 is lower. If this condition is indicated, close the affected engine's isolation valve and wait 3 minutes.

If lights not extinguished in approximately 3 minutes:

Isolation Valve (Previously Closed) - OPEN. This is the good system and it will restore pressure so that the other system may be shut down.

Other Isolation Valve - CLOSED. By the previous action, it has been determined that this is the bad side, caused by a leak in the fuselage ducting.

When both lights are extinguished:

Maintain 30 PSI minimum from good system. Use only the good side. Do not open crossfeed. If bad side was No. 1 do not use APU air.

If both system fail lights and both duct over pressure lights illuminated and/or both mains pressure ZERO:

Crossfeed Valve - CLOSE. The open crossfeed valve is the reason for a double failure. One system is overpressured and transmitted the overpressure through the open crossfeed valve and shut down both systems. CLOSE the crossfeed valve, then reinstate each system ONE AT A TIME.

Reset Buttons - PRESS, ONE AT A TIME. This will reinstate each system. Monitor mains pressure. The bad system will show a definite surge of pressure and shut down again. When the bad system has been determined, CLOSE the isolation valve and PRESS reset button to extinguish light. The crossfeed valve can be opened to operate both sides. If anti-icing valves were open during failure, close anti-icing valves on bad side, then OPEN crossfeed valve. With an overpressure condition, if both air sources are needed, pressure can be controlled by manipulation of the throttle at reduced power.

Refer to DUCT OVER PRESSURE LIGHT ON abnormal procedure in this section.

NOTE: The aircraft may be air conditioned and pressurized from the APU at altitudes of 17,000 feet and below depending on ambient temperature and restricting the APU generator to approximately 8 KW.

MAC VALVE AND SYSTEM FAIL LIGHT ON

MAC Valve - CLOSE. If the light extinguishes, it confirms that the faulty system has been isolated.

Air Inlet Temperature - CHECK. This gauge will identify either a 185° CAU overheat (bottom of gauge) or a 70° duct overheat (top of gauge).

Cabin/Flight Deck Temperature Valves - REPOSITION IN MANUAL AND ADJUST TEMPERATURE AS NECESSARY.

MAC Valve - OPEN. This will reopen the valve and reinstate the system. If the lights illuminate once again, CLOSE MAC Valve and accept loss of that air conditioning pack.

NOTE: Both the MAC valve light and the system fail light illuminated simultaneously indicates automatic closure which:

- Closes MAC valve.
- "Fast" closes isolation valve.
- Closes PRV valve.
- Closes crossfeed valve.
- If failure on No. 1 system, air delivery valve closes also.

If air supply is lost from one engine due to engine shut down, faulty air supply, or stub duct problem, OPEN crossfeed valve and operate both air conditioning packs from good engine. There is no restriction in RPM during descent if anti-ice is not in use. If using both air conditioning packs, plus anti-icing, maintain 72% HP RPM or flight idle, whichever is greater, during descent.

Operations above 25,000 feet are not permitted if only one air conditioning system is available.

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SECTION 1-314

POWERPLANT

SUBJECT	PAGE NO.
ABNORMAL STARTS:	
- Hot Start	1-314-16
- Hung Start	1-314-16
- No Fuel Flow	1-314-16
- No Ignition	1-314-16
- No Oil Pressure	1-314-16
APU - EXTERNAL BATTERY ASSISTED STARTS	1-314-6
APU-GPU ASSISTED STARTS	1-314-5
APU OPERATIONAL - APU AC GENERATOR INOPERATIVE	1-314-19
CROSS BLEED START	1-314-15
DEPLETED BATTERIES	1-314-7
EXCESSIVE EGT	1-314-4
EXTERNAL AIR SUPPLY (AC POWER AVAILABLE)	1-314-17
EXTERNAL AIR SUPPLY (NO AC POWER AVAILABLE)	1-314-18
HIGH FUEL TEMPERATURE	1-314-1
OIL LOW PRESSURE WARNING LIGHT ON	1-314-3
TOP TEMPERATURE CONTROL (TTC) FAILURE	1-314-2
TWO-ENGINE FLAMEOUT	1-314-8

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HIGH FUEL TEMPERATURE

In the event of rising fuel temperatures, increase fuel flow in an attempt to prevent fuel temperature exceeding limitations. Monitor gauge readings throughout the remainder of the flight.

If fuel temperature exceeds limits and conditions permit, shut down the engine, as fuel seal damage may result in fuel leaks.

TOP TEMPERATURE CONTROL (TTC) FAILURE

Failure of TTC will probably be indicated by decrease in or inability to obtain desired P7 and/or N2 RPM. The maximum power loss that TTC system can cause is about 17% of P7 or 3.6% of N2 RPM. These indications will be accompanied by a proportionate reduction in fuel flow.

If TTC failure is suspected, place switch to OFF. Monitor EGT carefully and make throttle adjustment to assure EGT does not exceed limits. Leave switch OFF for the remainder of the flight.

Malfunction of the fuel dip feature of the TTC system will probably be indicated by excessive loss of P7 and N2 while the TTC switch is in ARM BOTH position.

If fuel dip malfunction is suspected, place switch to TTC ONLY position. If power is not fully restored, place switch to OFF. Leave switch OFF for the remainder of the flight.

OIL LOW PRESSURE WARNING LIGHT ON

If the oil low pressure warning light illuminates:

Respective Oil Pressure Gauge - CHECK.

- If pressure is low, shut down the engine IMMEDIATELY.
- If pressure is normal, the engine need not be shut down; however, the gauge should be closely monitored throughout the remainder of the flight.

Oil Pressure Light Cap - PULL. This will isolate the master warning.

Throttle back the engine. Should this prove unsuccessful, shut down the engine.

APU - GPU ASSISTED STARTS

An electrical "umbilical" cord approximately 4 feet long is located in the forward cargo compartment. The purpose of this cord is to allow the flight crew to connect a 28-volt DC power cart directly to the battery bus to power the APU starter if the battery condition is such that a successful APU start is in doubt, such as in the case of extremely cold weather. The use of the 28-volt DC power cart is in lieu of a 115-volt AC power cart (GPU), that would normally be used to top batteries and supply the battery bus.

This procedure should be used whenever the battery condition is such that a successful APU start is in doubt and a suitable 115-volt AC power cart is not available, or if the ambient temperature is 0°F or below, and at the Captain's discretion.

Whenever the umbilical cord is to be used, the following procedure shall be followed:

- Obtain a 28-volt GPU and position it to the left front of the aircraft, so that it may be seen by the Captain from the cockpit.
- Remove the E & E compartment door and place it in front of the nose wheel tires.
- Remove ONE of the batteries "quick disconnects".
- Take the male end of the umbilical cord that is rigged for the battery quick disconnect and join it to the battery quick disconnect that was just removed from the battery.
- Connect the other end of the umbilical cord, with three male prongs, to the GPU female connection.
- Start the GPU. Check for a regulated 28 volts and then activate the "line" switch.
- Allow the battery that is still connected to its quick disconnect to receive approximately a 10-minute charge.
- Start the aircraft's APU and put its generator on-the-line.
- Turn the battery switch to the OFF position.
- Turn the GPU line switch OFF and shut down the GPU.
- Disconnect the umbilical cord from the GPU cord.
- Disconnect the umbilical cord from the battery quick disconnect. The battery switch being OFF will not provide a ground, thus eliminating a potential arcing condition in a closed area where batteries could be gassing.
- Connect the battery quick disconnect to the battery and insert the safety pin.
- Remove the umbilical cord and stow in the forward cargo compartment.
- Replace the E & E compartment access door.
- Stow the GPU.
- Turn the battery switch ON and monitor charging rate.

APU - EXTERNAL BATTERY ASSISTED STARTS

An electrical "auto battery jumper lead" type cord is located in the forward cargo compartment. The purpose of this cord is to allow the flight crew to connect two auto type batteries directly to the battery bus to power the APU starter if the aircraft's battery condition is such that a successful APU start is in doubt, such as in the case of extremely cold weather. The auto battery jumper lead is used in conjunction with the "umbilical" cord that is also stowed in the forward cargo compartment.

This procedure should be used whenever the battery condition is such that a successful APU start is in doubt and a suitable 115-volt AC power cart or a 28-volt DC power cart is not available, or if the ambient temperature is 0°F or below, and at the Captain's discretion.

Whenever the auto battery jumper lead is to be used, the following procedure shall be followed:

- Acquire two automobile type batteries and connect them in Series with the jumper wire which is stowed in the same container in the forward cargo compartment.
- Connect auto battery jumper lead to batteries; red lead to POSITIVE, black lead to NEGATIVE.
- Remove the umbilical cord from the forward cargo compartment as described in GPU-APU ASSISTED STARTS procedure.
- Connect the female end of the auto battery jumper lead to the end of the umbilical cords that has three male prongs.
- Remove the E & E compartment door and place it in front of the nose wheel tires.
- Remove ONE of the batteries "quick disconnects".
- Take the male end of the umbilical cord that is rigged for the battery quick disconnect and join it to the battery quick disconnect that was just removed from the battery.
- Start the aircraft's APU and put its generator on-the-line.
- Turn the battery switch to the OFF position.
- Disconnect the female end of the auto battery jumper lead from the end of the umbilical cord that has three prongs. Disconnect the umbilical cord from the battery quick disconnect. The battery switch being OFF will not provide a ground, thus eliminating a potential arcing condition in a closed area where batteries could be gassing.
- Connect the battery quick disconnect to the battery and insert the safety pin.
- Replace the E & E compartment access door.
- Disconnect the jumper wires from the two auto batteries and disconnect the auto battery jumper lead from the two auto batteries.
- Stow the umbilical cord, auto battery jumper leads, and jumper lead in the forward cargo cmpartment.
- Stow the two automobile batteries; not in the aircraft, except in suitable containers.
- Turn the battery switch ON and monitor charging rate.

DEPLETED BATTERIES

When battery voltage in both the aircraft's batteries has been depleted below the value which is necessary to activate the battery relay, charge on battery for approximately 5 to 10 minutes using the umbilical cord and 28-volt GPU as outlined in the APU-GPU ASSISTED START procedure in this section. This will ensure that the battery relay will close again when the battery switch is turned ON.

Some GPU's have unregulated amperage output. Keep the battery charging time to a minimum.

Notify Maintenance prior to using the depleted battery procedure.

TWO-ENGINE FLAMEOUT

With the remote possibility of a dual engine flameout, the following should be reviewed:

MAJOR SYSTEM AVAILABILITY

Pneumatics

Engine bleed air will not be available for cabin pressurization, anti-icing, or CSDS assisted engine starts. The discharge valve will close automatically, but cabin altitude will increase. The rate of increase will depend on fuselage leak rate, but eventually the cabin altitude warning horn will sound and there will be an automatic drop of the passenger oxygen masks. If required, flight crewmembers shall don their oxygen masks and establish cockpit communications. If passenger oxygen is required and the masks have not dropped automatically, release masks manually. The F/O should make a P.A. announcement instructing the passengers to pull their masks down and use oxygen and to extinguish all cigarettes.

Electrical Power

Generator electrical power will not be available, but essential electrical services, including the DC hydraulic pump and the electrically operated elevator trim tab will be supplied from the batteries. Normally, a battery duration of approximately 45 minutes may be expected. This may be reduced to a minimum of approximately 30 minutes should an unsuccessful attempt to start the APU had been made.

Communications/Navigation

The No. 1 VHF COMM and NAV units are available. In addition, the interphone and P.A. systems are usuable. The INS(s), if installed, will provide CDU information for approximately 15 minutes.

Cockpit Lighting

If required, turn up all cockpit lighting and have flashlights available.

APU

NOTE: Refer to APU Inflight Relight Envelope in Chapter 16 - POWERPLANT & APU for detailed information.

The APU may be restarted in flight at or below 20,000 feet at which altitude the minimum speed for restarting is 190 KIAS. Only one attempt to restart should be made to preserve battery power. With the APU running and its generator on-the-line, normal single generator operating electrical services will be available, only one of the AC auxiliary hydraulic pumps should be used at a time. Below 10,000 feet MSL, APU bleed air pressure will be adequate for a CSDS assisted engine relight.

(cont'd.)

TWO-ENGINE FLAMEOUT (cont'd.)

MAJOR SYSTEM AVAILABILITY (cont'd.)

Engine Relighting

NOTE: Refer to Inflight Start Relight Envelope in Chapter 1 - EMERGENCY for detailed information.

Successful engine relighting in flight has been demonstrated below 23,000 feet MSL using CSDS assistance below 220 KIAS and normal windmilling above this speed. It is recommended that the speed range between 215 and 225 KIAS be avoided. This does not preclude immediate or normal windmill relight attempts at any altitude. If any relight attempt is unsuccessful, the engine must be allowed to drain for at least one minute before a further relight attempt is made.

Hydraulics

Hydraulic pressure from a windmilling engine will vary with IAS, altitude, and internal leak rate within the hydraulic system. With the maximum permitted internal leak rate, at speeds greater than 200 KIAS and above 5,000 MSL, a reasonable amount should be taken to avoid excessive hydraulic demands which could lead to the powered flight controls reverting to the manual mode.

If hydraulic pressure drops to 1,500 PSI, the engine pump fail light(s) will illuminate and the system accumulator(s) will be exhausted. In this condition, demands on the system(s) may rapidly reduce available pressure.

If pressure falls below approximately 400 PSI, the powered flight controls will automatically revert to the manual mode. A subsequent increase of pressure above 400 PSI will automatically reinstate powered controls. If the APU is running with its generator on-the-line, selection of either the No. 1 or No. 2 AC auxiliary hydraulic pump will supply full hydraulic services for that system. In addition to providing hydraulic power for flight controls, the No. 1 hydraulic system provides pressure for landing gear extension, nose wheel steering operation, and extension of the lift dumpers. The No. 2 hydraulic system provides pressure for the wheel brakes.

NOTE: With only one generator on-the-line, only one AC auxiliary hydraulic pump should be operated at a time to avoid overloading the generator.

(cont'd.)

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TWO-ENGINE FLAMEOUT
(cont'd.)

PERFORMANCE

Optimum Glide Speeds

GROSS WEIGHT (1,000 LBS.)	60.0	65.0	70.0	75.0	80.0	85.0
OPTIMUM GLIDE SPEED (KIAS)	160	168	175	183	190	198

Chart speeds are KIAS and are slightly rounded off, i.e., 190 knots at 80,000 lbs., corrected by 1.5 knots per 1,000 lb. weight difference from 80,000 lbs.

These speeds provide at least 1.35 buffet margin and a glide ratio of about 11 to 1 or roughly 1.8 nautical miles per 1,000 feet with up to a 15° bank. These speeds also provide at least 1.30 margin above stall.

The chart speeds shown above may be lower then the Engine and APU Relight Envelope speeds. During restart attempts, the indicated airspeed may need to be increased as follows:

Above 23,000 Feet

Altitudes above 23,000 feet are outside the Engine Relight Envelope. Engine restarts should be attempted at an IAS of not less than 200 knots. At this speed, the glide ratio will be somewhat less than 9 to 1 or somewhat less than 1.5 nautical miles per 1,000 feet.

Above 20,000 Feet Up To and Including 23,000 Feet

Windmilling restarts of the engines must be used. The minimum speed for windmilling restarts is 200 KIAS. At this speed, the glide ratio is somewhat greater than 9 to 1 or roughly somewhat greater than 1.5 nautical miles per 1,000 feet.

Below 20,000 Feet

The APU may be started and subsequently used for a CSDS assisted engine start. The minimum speed for an APU start at 20,000 feet is 190 KIAS. At this speed, the glide ratio is somewhat greater than 10 to 1 or roughly somewhat greater than 1.6 nautical miles per 1,000 feet.

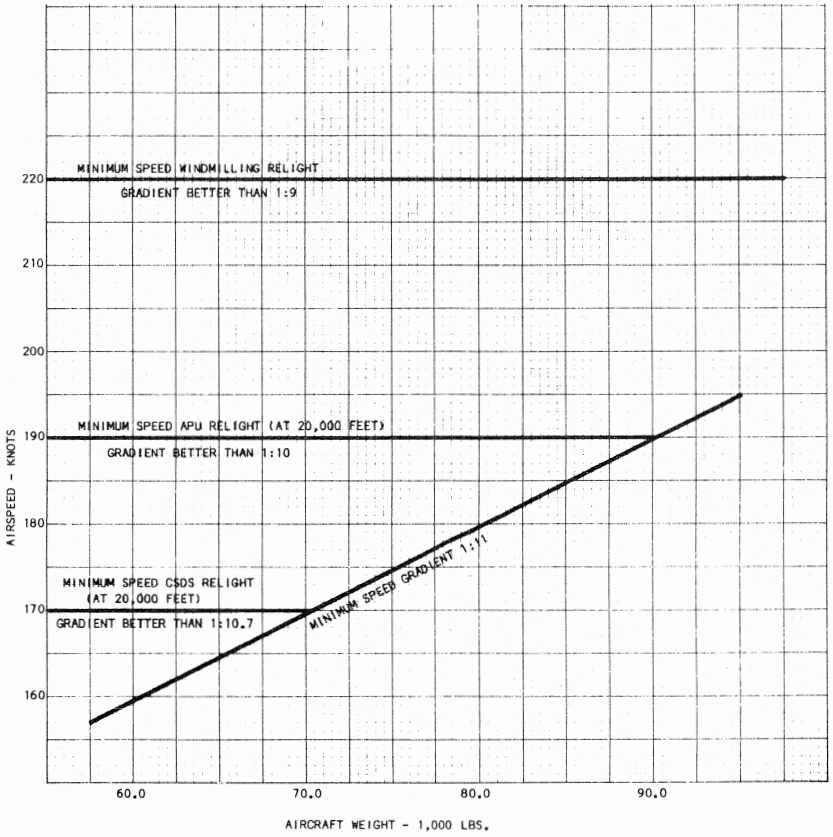
Once the APU is operating, the minimum speed for a CSDS assisted start at 20,000 feet is 165 KIAS. At this speed, the glide ratio is somewhat greater than 10.7 to 1 or roughly somewhat greater than 1.76 nautical miles per 1,000 feet.

(cont'd.)

TWO-ENGINE FLAMEOUT (cont'd.)

PERFORMANCE (cont'd.)

CHOICE OF AIRSPEED AND CORRESPONDING GLIDEPATH GRADIENT



(cont'd.)

TWO-ENGINE FLAMEOUT (cont'd.)

CREW ACTIONS

As soon as engine flameouts are recognized, immediate relights should be attempted on both engines. If above 15,000 feet MSL, crew oxygen masks should be donned, oxygen flow checked, and communications established. Establish passenger flow, if required. If possible, the cause of the flameouts should be established and rectified. Fuel system mismanagement is the most probable cause. If the immediate relight is not successful on at least one engine, both HP fuel valves should be CLOSED and the engine allowed to drain for at least one minute. A speed of 225 KIAS should be maintained, which will give a reasonable but not optimum glide path gradient but this speed will be above the minimum windmill relight speed. Windmill relights should be attempted on each engine in turn until successful. If a relight is unsuccessful, at least a one minute drain period should be allowed to elapse before a further relight attempt is made on that engine.

If by 20,000 feet MSL, at least one engine has not been successfully relit, the APU should be started to restore normal one generator electrical services. Only one attempt should be made to start the APU in order to conserve battery power.

If the APU start is not successful, engine windmill relight attempts should be continued until successful.

If the APU start is successful, its generator should be checked on-the-line and all fuel boost pumps and the No. 1 AC auxiliary hydraulic pump selected ON. Further attempts should now be made to windmill relight each engine in turn until successful.

If by 10,000 feet MSL, and with the fuel boost pumps operating, at least one attempt to relight each in turn has been made and at least one engine has not relit, the speed should be reduced to the optimum glide path gradient speed as shown on the graph in this section, and CSDS assisted relights, using APU bleed air, should be attempted on each engine in turn until successful.

If neither engine can be relit, the aircraft must be prepared for a ditching or a forced landing. If there is an airport within gliding distance, every effort should be made to carry out a forced landing on that airport.

If the APU is running with its generator on-the-line and No. 1 AC auxiliary hydraulic pump ON, flaps and landing gear can be selected as required and normal powered flight controls will be available.

Keep in mind that once on the profile, varying distances to the runway threshold can effect the touchdown point. If available, utilize INS wind and ground speed readouts and surface indications of wind direction and velocity. Adjust flap setting to vary touchdown point.

- To the extent possible, complete all required checklists and expanded checklists.

- Brief all crewmembers on their duties.

- Arrive overhead and circle the airport. Increase airspeed so as to arrive at the end of the downwind leg at 250 KIAS and 1,500 feet AGL.

(cont'd.)

TWO-ENGINE FLAMEOUT (cont'd.)

CREW ACTIONS (cont'd.)

If the APU is running (cont'd.)

- On turning base leg, allow the airspeed to start decreasing.

- Select 18° flap and landing gear down.

- When the landing gear is down and locked, check brake accumulator pressures. The DC hydraulic pump may be used to top off accumulators, if necessary. Do not operate the No. 2 AC auxiliary hydraulic pump at the same time as the No. 1 AC auxiliary hydraulic pump is operating. It could overload the APU generator.

- The distance to the runway threshold, altitude, airspeed, and wind velocity must be continually assessed and the approach path modified as necessary by positioning the aircraft and the use of flaps to ensure touchdown at the correct point.

- Once over the end of the runway, LAND AS SOON AS POSSIBLE, using spoilers if necessary. Use maximum anti-skid braking to stop the aircraft.

If the APU is not running, consideration should be given to flying a normal airspeed, high altitude approach and landing pattern.

Keep in mind that once on the profile, varying distance to the runway threshold can effect the touchdown point. If available, utilize surface indications of wind direction and velocity. Adjust flap setting and airspeed to vary touchdown point.

- To the extent possible, complete all required checklists and expanded checklists.

  NOTE: In addition to the material outlined under CREW ACTIONS - APU running, review abnormal procedure for LOSS OF BOTH HYDRAULIC SYSTEM NO. 1 & HYDRAULIC SYSTEM NO. 2 in Chapter 1, Section 1-310 of this manual.

- Brief all crewmembers.

- Arrive overhead and circle the airport. Plan to arrive at the end of the downwind leg at 5,000 feet AGL with the airspeed reducing to achieve a target of 160 KIAS by the time the flaps have reached 18°.

- As the airspeed decreases, extend flaps on schedule to 18°. Keep in mind that it may require up to 4 to 5 minutes to extend the flaps to 18° and the selected position may not be fully reached at speeds in excess of 200 KIAS.

- Lower the landing gear by free fall.

- When the flaps reach 18° and the landing gear is down and locked, the DC hydraulic pump can be used to top off the brake accumulators.

- Select standby steering switch ON.

(cont'd.)

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TWO-ENGINE FLAMEOUT
(cont'd.)

CREW ACTIONS (cont'd.)

If the APU is not running (cont'd.)

- As the airspeed is reduced, the hydraulic pressure available will also reduce and may reach a level where the flight controls will revert to manual mode (approximately 400 PSI). Consideration should be given to selecting both flight control hydraulic shutoff levers to OFF and, thus reverting to manual control at a time of the pilot's discretion.

- Once over the runway, LAND AS SOON AS POSSIBLE. Hydraulic pressure from the windmilling engines may not be sufficient to extend the spoiler and/or lift dumper. If both flight control hydraulic shutoff levers are positioned to OFF, the spoilers will not extend.

- Use maximum anti-skid braking to stop. One anti-skid and six hand brake applications are available with full accumulators.

CROSS BLEED START

After one engine is started from the APU or an external pneumatic source, the other engine can be started by crossbleeding air from the operating engine.

MAC Valves - CLOSE.

Crossfeed Valve - OPEN.

APU Delivery Valve - CLOSE.

Advance engine power to approximately 80% HP RPM, check mains pressure (25 to 30 PSI), and start engine.

NOTE: Valve positions would be the same for starting from an external air supply.

ABNORMAL STARTS
HOT OR HUNG/NO IGNITION/NO FUEL FLOW/NO OIL PRESSURE

Types of unsatisfactory starts and their associated indications are as follows:

HOT START

Initial fuel flow high and/or abnormally rapid rise of TGT. 550°C is maximum TGT with OAT below 20°C and 570° is maximum TGT with OAT 20°C or above.

HUNG START

HP RPM acceleration that becomes sluggish or stops prior to reaching normal idle RPM.

NO IGNITION

Fuel flow, but no TGT rise within 10 seconds after advancing the HP cock.

NO FUEL FLOW

No fuel flow after advancing the engine start lever.

NO OIL PRESSURE

Oil pressure is less than 16 PSI at idle RPM.

IMMEDIATE ACTION:

HP Fuel Lever - SHUT.

Start Master Selector - OFF.

RESTART:

Fuel Drain Down - Wait 2 to 3 minutes before attempting to restart engine.

Start Master Switch - MOTOR ONLY.

Engine Start Switch - MOMENTARILY TO START/MOTOR ONLY. Motor engine for 30 seconds.

Start Master Switch - OFF. Allow engine HP RPM to return to zero RPM.

Start Master Switch - START.

Engine Start Switch - MOMENTARILY TO START AND MOTOR.

HP Fuel Lever - OPEN, after 12% HP RPM. Proceed as with normal start.

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EXTERNAL AIR SUPPLY (AC POWER AVAILABLE)

After ground crew has completed the external air supply connection, proceed as follows:

Battery Switch - ON.

Before Start Checklist (J-CHECK) - COMPLETE.

Air Delivery and Crossfeed Valves - CLOSED.

Check duct pressure on cockpit gauge at minimum of 25 PSI.

When LP shaft rotation light begins to flash and HP RPM is at 13%:

HP Fuel Valve - OPEN.

After starting the right engine:

Right Isolation Valve - CLOSED. Wait until the ground crew has completed removal of the external air supply to prevent possible injury to them.

Right Isolation Valve and Air Crossfeed - OPEN.

Check duct pressure at minimum of 25 PSI. Boost right engine to approximately 75% in order to achieve this.

Complete left engine start by crossbleeding from right engine.

EXTERNAL AIR SUPPLY (NO AC POWER AVAILABLE)

After ground crew has completed external air supply connection, proceed as follows (right engine must be started first):

Battery Switch - ON.

Before Start Checklist (J-CHECK) - COMPLETE.

Start Master Switch - START (or START No. 2, some aircraft).

Start/Relight Switch - START, MOMENTARILY.

NOTE: Check to insure HP tachometer RPM indicates 17-18% minimum. If so, the external air supply is adequate to start engines. Place HP fuel valve to OPEN and complete the start.

If indications are less than minimum, do not use the start cart.

After starting right engine:

Right Isolation Valve - CLOSED.

Crossfeed Valve - CLOSED. Wait until the ground crew has completed removal of external air supply, to prevent possible injury to them.

Right Engine Generator - RESET.

Voltage/Frequency - CHECK.

Oil Pressure - 16 PSI MINIMUM.

Hydraulic Pump - ON. Check pressure.

Isolation and Crossfeed Valves - OPEN.

Start left engine in normal manner.

APU OPERATIONAL - APU AC GENERATOR INOPERATIVE

With APU air available (to the No. 1 pack) and the AC generator inoperative, the left engine must be started first. The air crossfeed valve cannot be opened. In addition, the fuel booster pumps and fuel flow indicator will not be powered. The No. 2 mains pressure indicator will read top scale (about 80 PSI, not powered), and the No. 1 mains pressure indicator is powered and will indicate APU air pressure available.

Before Start Checklist (J-CHECK) - COMPLETE.

Start Master Switch - START (or START No. 1, some aircraft).

Start/Relight Switch - START, MOMENTARILY.

NOTE: Check normal HP and LP tach and green LP shaft light indications; at 13% HP RPM, place HP fuel valve to OPEN position.

When engine reaches idle RPM and TGT:

Start Master Switch - OFF.

Left Engine Generator - RESET.

Voltage and Frequency - CHECK.

Check the following:

- Igniter lights extinguished.
- LP shaft rotation light extinguished.
- Engine fuel LP light extinguished.
- Oil pressure 16 PSI minimum.
- HP RPM 58% to 62%.
- CSD oil pressure and bus fail lights extinguished.
- DC bus fail lights extinguished.
- Check KVA reading.
- Check hydraulic pump ON, check pressure.
- CLOSE the left isolation valve.
- OPEN the crossfeed valve.

NOTE: Allow time for the APU EGT to stabilize prior to starting the second engine.

Start No. 2 engine from APU.

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COMPASS OFF FLAG APPEARS IN RMDI

INDICATES: Loss of power to the compass system. The HDG CARD flag in the CDI being supplied by the failed compass system will also appear.

Respective Compass C/B - CHECK.

If unable to reinstate failed compass system:

CDI Select Switch - ALT. Position CDI Select switch, either Captain's or F/O's, to ALT to reinstate failed CDI compass card.

FAILURE OF RMDI TO SLAVE

If RMDI fails to slave or slaves to an incorrect compass heading, the compass system may be operated as a straight (free) directional gyro as follows:

RMDI Mode Switch - FREE GYRO. Maintain correction magnetic heading by pushing and rotating knob on RMDI as required. The CDI card(s) will still repeat the RMDI card even when operating in FREE GYRO mode.

GYRO TUMBLED

If gyro has fallen off more than 5°, fast erect by tripping circuit breaker for 2 minutes, then reinstate.

If gyro has fallen off about 60°, trip circuit breaker for 15 minutes, then reinstate (gyro spins down completely, then needs only about 2 minutes because it re-erects in fast erection cycle.

GS or VOR/LOC FLAG APPEARS

INDICATES: Failure or unreliability of radio signal from respective receiver.

Check respective GS or VHF NAV circuit breaker.

INDICATES: Failure of compass system (RMDI) supplying CDI card or CDI card not correctly repeating RMDI card (more than 5° difference).

Check for compass OFF flag in opposite RMDI. If flag in-view, see COMPASS OFF FLAG APPEARS IN RMDI abnormal procedure in this section.

If RMDI is normal, check CDI circuit breakers. If the circuit breakers are okay, try ALT position of CDI select switch.

With HDG CARD flag in-view, COMPUTER flag in HDI will also be in-view in any mode other than OFF. If unable to reinstate CDI card, "command" guidance from steering computer is not available.

GYRO FLAG APPEARS

INDICATES: Failure of respective vertical gyro, HDI not properly repeating gyro signals, or gyro is in fast erection mode.

NOTE: It is normal for GYRO flag to be in-view up to 3 minutes after power is applied to gyro.

HDI Select Switch - ALT. (Captain or F/O). Failed HDI should then repeat "good" HDI and GYRO flag should disappear.

HDI Attitude and Vertical Gyro C/B's - CHECK.

NOTE: With GYRO flag in-view, COMPUTER flag in HDI will also be in-view in any mode other than OFF.

INDICATES: Failure or unreliability of radio from respective VHF NAV receiver. VOR/LOC flag in CDI will appear concurrently.

Check tuning of respective VHF NAV receiver. Check VHF NAV circuit breaker.

With the VOR/LOC flag in-view, COMPUTER flag in HDI will be in-view in the V/L and GS modes. If unable to reinstate the receiver, "command" guidance from the steering computer in these modes is not available; however, "command" guidance is available in the HDG mode.

INDICATES: Failure or unreliability of signal from respective glideslope receiver. GS flag in CDI will appear concurrently.

Check tuning of respective VHF NAV receiver. Check respective GS circuit breaker.

V-bar bank commands are unaffected when GS flag appears by itself. In GS mode, if GS flag appears, COMPUTER flag will also appear after glideslope intercept.

COMPUTER FLAG APPEARS

Check for failure of HDI V-bar inputs and concurrent appearance of additional warning flags per the following table:

	NAV WARNING FLAGS (Based on Input Failures)			
HDI MODE	VHF NAV (Excluding Glideslope) Power Loss; Unreliable Signal; or Not Tuned.	COMPASS Power Loss or Failure.	VERTICAL GYRO Power Loss; Fast Erection; Pitch & Roll Readouts not Repeating Gyro	STEER COMPUTER Power Loss
OFF	VOR/LOC	HDG CARD OFF	GYRO	COMPUTER
HDG	VOR/LOC	HDG CARD COMPUTER OFF	GYRO COMPUTER	COMPUTER
V/L	VOR/LOC COMPUTER	HDG CARD COMPUTER OFF	GYRO COMPUTER	COMPUTER
GS	VOR/LOC COMPUTER	HDG CARD COMPUTER OFF	GYRO COMPUTER	COMPUTER

If any malfunction other than input from steering computer is indicated, attempt to correct that malfunction.

If steering computer malfunction is probable (malfunction unaccompanied by any other flag), check the following steering computer circuit breakers:

- Steer Computer #1 - C/B #440
- Steer Computer #2 - C/B #455

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PREFACE

Limitations designated **AFM** are those which the FAA-Approved Airplane Flight Manual impose a certificate limitation. In all cases, the limitations contained herein are equal to or more conservation than limitations in the FAA-Approved Airplane Flight Manual.

All references to airspeed or Mach number relate to Indicated Airspeed (IAS) or Indicated Mach Number, unless otherwise noted. All references to altitude relate to Pressure Altitude, unless otherwise noted.

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WEIGHT LIMITS

CERTIFICATE WEIGHT LIMITATIONS (AFM)

Maximum Ramp Weight: 87,500 lbs.

This is the maximum allowable weight prior to departure from the ramp. It is selected to allow for a 500 lb. taxi fuel "credit" without exceeding Maximum Takeoff Weight.

Maximum Takeoff Weight: 87,000 lbs.

This is the maximum allowable weight at brake release.

Maximum Landing Weight: 78,000 lbs.

All weight in excess of Maximum Landing Weight must consist of disposable fuel.

Maximum Zero Fuel Weight: 68,500 lbs.

All weight in excess of Maximum Zero Fuel Weight must consist of fuel.

The Maximum Zero Fuel Weight will decrease by the amount of fuel added to the fuselage fuel tanks (if installed).

Maximum Zero Fuel Weight with Maximum Fuselage Fuel: 60,600 lbs.

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OPERATIONAL LIMITS

MINIMUM FLIGHT CREW:

Pilot and Copilot **(AFM)**

TAKEOFF AND LANDING TEMPERATURE RANGE:

-50°C (-58°F) to STD +35°C **(AFM)**

TAKEOFF AND LANDING ALTITUDE RANGE:

-1,000 feet to +8,500 feet **(AFM)**

RUNWAY SLOPE LIMIT:

±2% **(AFM)**

MAXIMUM TAILWIND COMPONENT FOR TAKEOFF AND LANDING:

10 knots, unless values are further limited.

DEMONSTRATED CROSSWIND:

The maximum demonstrated cross value for takeoff and landing is 30 knots, reported at an altitude of 33 feet. However, the maximum crosswind component authorized in Company operations is 26 knots, unless a lesser value is specified.

MAXIMUM OPERATING ALTITUDE:

40,000 feet, but operations at altitudes above 35,000 feet are not permitted unless only aviation kerosene fuel is used. **(AFM)**

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SPEED LIMITS

MAXIMUM OPERATING LIMIT SPEED:

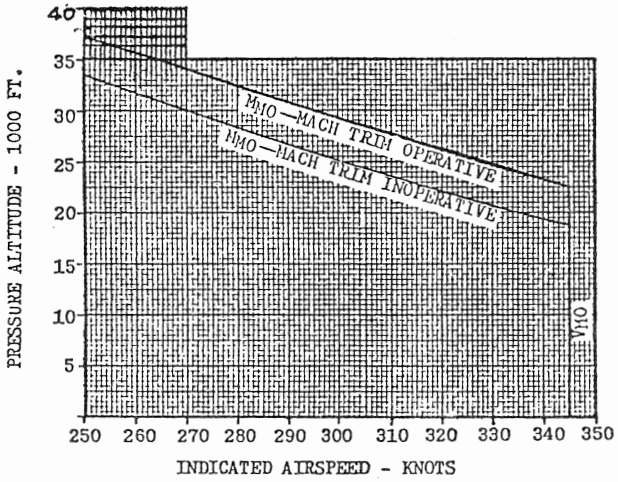
V_{MO}: 345 knots **(AFM)**
335 knots (Company)

M_{MO}: .78 Mmo (mach trim OPERATIVE) **(AFM)**
.76 Mmo (mach trim OPERATIVE) (Company)

.72 Mmo (mach trim INOP) **(AFM)**

NOTE: Maximum Operating Limit Speed Vmo/Mmo shall not be deliberately exceeded in any flight regime (climb, cruise, or descent).

The following is a graphic presentation of Vmo/Mmo:



MAXIMUM GEAR OPERATING SPEED: (AFM)

V_{LO}: 230 knots (Extension and Retraction)

M_{LO}: No Mach Limit.

NOTE: If a gear door does not fully close following gear extension or retraction (gear unsafe light illuminated), limit speed to 230 knots.

MAXIMUM GEAR EXTENDED SPEED: (AFM)

V_{LE}: Vmo/Mmo (After Normal Extension)
230 knots (After Free Fall)

M_{LE}: No Mach Limit.

NOTE: If a gear door does not fully close following gear extension or retraction (gear unsafe light illuminated), limit speed to 230 knots.

(cont'd.)

SPEED LIMITS

MAXIMUM FLAPS OPERATING AND EXTENDED SPEEDS:

BEYOND 0° BUT NOT EXCEEDING 18°:	240 knots **(AFM)** 230 knots (Company)
BEYOND 18° BUT NOT EXCEEDING 26°:	190 knots **(AFM)** 180 knots (Company)
BEYOND 26°:	180 knots **(AFM)** 170 knots (Company)

MANUAL REVERSION OF ELEVATOR:

270 knots

MAIN LANDING LIGHTS OPERATING AND EXTENDED SPEED:

Vmo/Mmo

NOSE LANDING LIGHT OPERATING AND EXTENDED SPEED:

OPERATING: 185 knots (No Mach Limit) **(AFM)**

EXTENDED: Vmo/Mmo **(AFM)**

WINDSHIELD WIPER OPERATING SPEED:

220 knots **(AFM)**

MAXIMUM TIRE GROUND SPEED:

The maximum ground speed approved for the main and nose gear tires is 174 knots. However, if it should become necessary to exceed this limit, the tires should be carefully inspected for possible tread separation and a log book entry must be made.

LIGHTING

INSTRUMENT PANEL FLOODLIGHTS:

In order to assure sufficient lighting in an emergency, instrument panel floodlights, controlled by RED FLOOD rheostat, must be ON at an adequate brightness for all night takeoffs and landings. **(AFM)**

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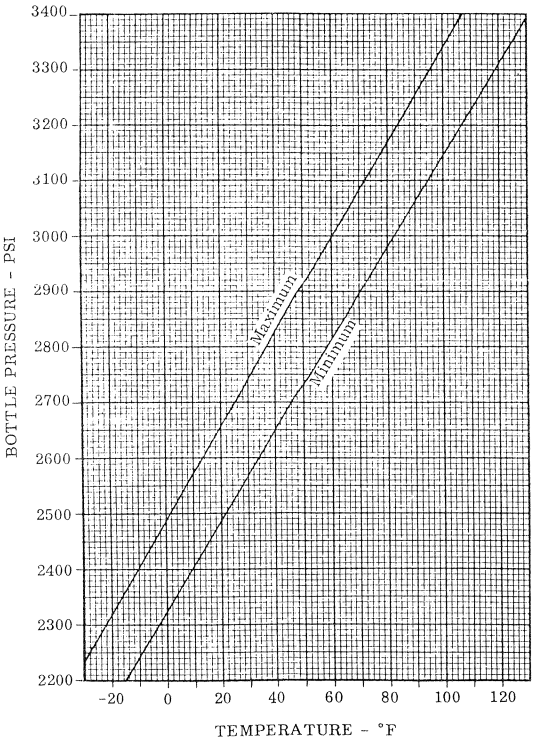
EMERGENCY EQUIPMENT

EVACUATION SLIDES

Air Bottle Pressure Versus Ambient Air Temperature Chart:



Retaining Hook

The retaining hook of all door-mounted escape slides must be attached to the floor attach point during taxi, takeoff, and landing whenever passengers are being carried.

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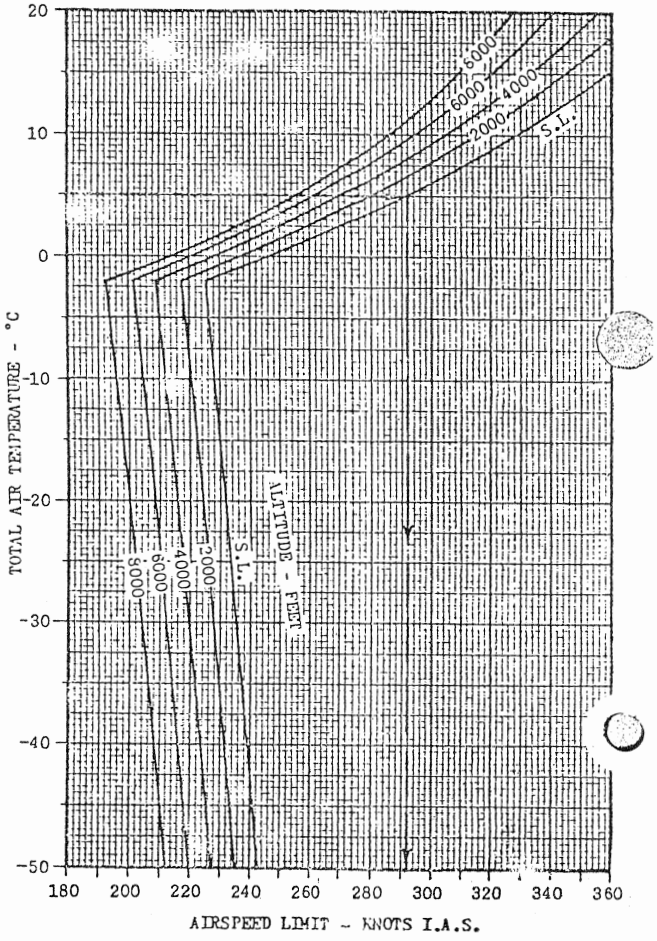
ICE & RAIN PROTECTION

AIRSPEED LIMITS

WINDSHEILD HEAT INOPERATIVE OR WINDSHIELD DAMAGED



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ELECTRICAL

AC SYSTEM LIMITATIONS

AC Generator Voltage: 115 ±5 VOLTS

AC Generator Frequency: 400 ±8 CPS

NOTE: Voltage and frequency ranges apply to both engine generators and APU generators. In the case of APU generator frequency tolerance, the range may widen as altitude increases, 400 (+12 to -8) CPS.

AC Generator Load: (AFM)

- The maximum permissible continuous load on each generator is 30 KVA at altitudes up to and including 37,000 feet.
- Above 37,000 feet, the maximum permissible continuous load on each generator is 22 KVA.

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AUXILIARY POWER

APU AIR SUPPLY:

The normal, abnormal, and emergency use of the APU air supply shall be observed so that at no time is air from either engine and from the APU being delivered simultaneously into a common duct.

The intent of the foregoing limit is that the engine and APU air valves be kept positioned such that APU air and engine bleed air are never in opposition, except very briefly when selecting new air source.

USE OF APU AS ESSENTIAL EQUIPMENT: (AFM)

The APU may be used as essential equipment provided that the following limitations are observed:

- Airplane must not be operated above 30,000 feet.
- Left wing tank sump must be drained before departure and at each enroute stop where airplane is refueled.
- Segment flight time shall not exceed 3-1/2 hours.
- Generator voltage/frequency selector shall be left in the APU GEN position (except for periodic checks of other generator output).

APU AIR SUPPLY AND INTEGRATED AIR SYSTEM: (AFM)

The following limitations on the use of the APU shall be observed:

- The APU may be used to supply electrical power and the air system at altitudes up to 10,000 feet.
- At altitudes at or above 10,000 feet, the APU may only be used to supply electrical power or the air system.
- The maximum altitude at which the APU may be used to supply the air system is 17,000 feet.

APU EXHAUST GAS TEMPERATURE LIMIT:

MAXIMUM CONTINUOUS: 677°C

ABSOLUTE LIMIT: 710°C

If EGT exceeds this value, shut down the APU and enter peak temperature and duration above 710°C in the log book for subsequent Maintenance action.

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FUEL LIMITS

ENGINE FUEL TEMPERATURE: (AFM)

- MAXIMUM CONTINUOUS: 90°C

- MAXIMUM FOR 15 MINUTES: 110°C

FUEL DISTRIBUTION ASYMMETRY:

- TAKEOFF: 1,000 lbs. between wing tanks (maximum) **(AFM)**

- INFLIGHT & LANDING: 4,500 lbs. between wing tanks (maximum)

NOTE: Good pilot technique dictates that, to extent possible, an equal fuel load be maintained in wing tanks. Asymmetry of 1,000 lbs. between wing tanks should never be exceeded except in emergency conditions.

FUEL SPECIFICATIONS: (AFM)

STANDARD FUEL SPECIFICATION: ESE-200 (JET A)

NOTE: If ESE-200 is not available, kerosene of aircraft grade manufactured by any major oil company and stocked for use by other airlines may be added to existing quantities of ESE-200 without restriction.

If ESE-200 or an equivalent kerosene used by other airlines is not available, JP-4 may be used as an emergency measure provided Operations approval is obtained. If use of JP-4 is approved, it may be added to kerosene in aircraft tanks provided underwing fueling is used. Also, any additional safety precautions and procedures described elsewhere in this manual must be observed.

AVIATION WIDE-CUT FUELS: The use of aviation wide-cut fuels is not approved for flights above 35,000 feet.

FUEL JETTISONING: (AFM)

Fuel shall not be jettisoned with the flaps extended more than 18°.

CENTER TANK TRANSFER PUMPS: (AFM)

Turn center tank fuel transfer pumps OFF when the LP light illuminates.

FUEL BOOST PUMP CIRCUIT BREAKERS: (AFM)

If a fuel boost pump circuit breaker should TRIP, do not RESET until the affected boost pump electrical connector has been inspected by Maintenance. If this situation arises, make an entry in the log book to ensure the above referenced inspection is accomplished.

(cont'd.)

FUEL LIMITS

FUSELAGE FUEL TANKS (IF INSTALLED): (AFM)

Fuel Loading Limitations:

- Fuel may be carried in fuselage tanks only when outer wing and center section tanks are FULL.
- Fuselage tanks shall be filled in the order CENTER, AFT, FORWARD. Each tank must be FULL before filling the next tank.
- Fuselage fuel tanks shall not be loaded when any of the following items are inoperative:
  - Fuselage fuel tank forward or aft refuel valve.
  - Forward, center, or aft fuselage fuel tank shutoff valve.
  - Fuselage fuel tank transfer pump.

Operational Limitations:

- Takeoff is prohibited when red light on the cockpit fuselage fuel panel is illuminated. Refuel valves must be CLOSED to extinguish the light.
- All fuel must be transferred from fuselage tanks before beginning transfer from wing center section tank.
- All fuel must be transferred from each fuselage tank before selecting another tank in the order: FORWARD, AFT, CENTER.
- Only one fuselage fuel tank shutoff valve may be open at a time.

PNEUMATICS, AIR CONDITIONING, AND PRESSURIZATION

AIR CONDITIONING

Operations above 25,000 feet are not permitted if:

- Only one air conditioning sysem is operative.

- Only one air system is operating (APU and one air system inoperative).

The normal, abnormal, and emergency use of the APU air supply shall be observed so that at no time is air from either engine and from the APU being delivered simultaneously into a common duct.

The intent of the foregoing limit is that the engine and APU air valves be kept positioned such that APU air and engine bleed air are never in opposition, except very briefly when selecting new air source).

The maximum altitude at which the APU may be used to supply the air system is 17,000 feet.

PRESSURIZATION: (APM)

Takeoff and Landing:

The airplane shall not be pressurized during takeoff and landing.

Maximum Pressure Differential:

NORMAL OPERATION: 8.2 PSI.

NORMAL SYSTEM MALFUNCTION: 8.7 PSI.

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HYDRAULICS, BRAKES, AND LANDING GEAR

HYDRAULICS

Hydraulic Pressure:

System No. 1 and No. 2 (engine-driven pumps and auxiliary pumps): 2,875 to 3,175 PSI.

Hydraulic Fluid Quantity:

MINIMUM FOR DISPATCH: 2 gallons indicated.

Standby Steering System: (AFM)

The standby steering system should be turned ON only when required and after the nose gear has been locked down. It should not be used if the No. 1 hydraulic system is serviceable, except following landing gear emergency extension or in the event steering is uncontrollable.

DC Hydraulic Pump:

The DC hydraulic pump is limited to an operating cycle of 2.5 minutes ON, followed by a 20-minute cooling period, except in an emergency situation where other action is deemed necessary.

BRAKES

Anti-Skid System: (AFM)

The brake anti-skid master switch is to be OFF at all times while taxiing near buildings, other aircraft, or any object which could cause a collision hazard.

Brake Temperature:

Brake temperature must be less than 200°C before starting takeoff roll.

Do not retract gear if brake temperature exceeds 400°C, unless required to increase aircraft performance. If gear is retracted, re-extend gear when practicable for cooling.

Brake Wear Limits:

Brake assembly must be replaced when, with brakes applied, either brake wear indicator is less than flush with the brake housing.

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FLIGHT CONTROLS

SPEED BRAKE OPERATION: (AFM)

The speed brakes may be extended at any speed but they must not be extended when the flaps are extended, except on the ground.

FLAP OPERATIONS: (AFM)

Flaps may not be extended at altitudes above 15,000 feet.

EMERGENCY ELEVATOR SYSTEM: (AFM)

Emergency elevator system must not be switched ON when either normal hydraulic system is supplying power to the elevators.

RUDDER AND AILERON TRIM:

If aileron or rudder trim requirements appear to be excessive in normal cruise, check that engine thrust and fuel loading are approximately symmetrical and that airplane has been trimmed as follows:

Bring the airplane into trim by holding rudder and/or aileron pressure manually, then crank in sufficient trim to reduce the manual pressure to zero.

This procedure will usually reduce the number of trim knob revolutions required to trim the airplane by reducing the load on the trim mechanisms. Then, if the airplane requires more trim than the following chart illustrates, enter the condition in the log book.

LATERAL TRIM COMPLAINTS

SPEED	ALLOWABLE TRIM LIMIT	
	Aileron	Rudder
Up to 150 knots	1 unit	1 unit
150 to 320 knots	3 units	1 unit
320 knots to Vmo	10 units	1 unit

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INST/NAV/COMM

FLIGHT INSTRUMENTS

Altimeters

Ground Check:

Set altimeters (Captain's and First Officer's) to current local "altimeter setting". Lightly tap the face of each instrument to assure settled reading. The two altimeters should indicate published field elevation plus or minus the following:

FIELD ELEVATION (Feet ASL)	TOLERANCE (Feet)
S.L. to 2,000	-30/+40
2,000 to 3,000	-35/+45
3,000 to 4,000	-40/+50
4,000 to 5,000	-45/+55
5,000 to 6,000	-50/+60
6,000 to 7,000	-55/+65
7,000 to 8,000	-60/+70

NOTE: As published field elevation is the elevation of the highest point on usable surface (runways), allowance should be made for any difference in elevation of ramp or point at which check is made.

If any altimeter is not within the limit specified above, it must be entered in the airplane log book and required corrective action must be taken prior to takeoff.

In Flight:

No in flight adjustment shall be made to any altimeter to compensate for error observed during ground check.

RMDI Radio Magnetic Bearing:

With mode selectors in VOR position, needle indications in each individual RMDI must show correct bearings ±5° (as checked against CDI).

With both VHF NAV's tuned to the same VOR station, the allowable difference between the single and double needles is 7-1/2° (either the same RMDI, or between the single needle on the Captain's and the double needle on the First Officer's RMDI, or vice versa). With ADF or VOR station tuned, the allowable difference between double needles is 1° and the same applies to single needles.

RMDI/CDI Compass Card Indications:

CDI compass card must agree with compass card of the RMDI to which it is slaved, ±1°.

Captain's and First Officer's RMDI compass card indications must agree within 5°.

(cont'd.)

INST/NAV/COMM

FLIGHT INSTRUMENTS (cont'd.)

Course Deviation Bar Ground Checks

At stations having an approved VOR test facility:

The bar should center with a course selection of 180° ± 4°. Adjusting course selection 10° in each direction from the established bearing that centered the bar should deflect the bar 2 dots or more.

At stations having an FAA certified checkpoint or airport surface:

With airplane parked at certified checkpoint, adjust course selection until bar centers. The course cursor should indicate certified bearing ±4°. Adjusting course selection 10° in each direction should deflect the bar 2 dots or more.

NOTES: In both of these checks, the Captain's and First Officer's indications should agree within 4°.

No in-flight adjustment shall be made to any VOR or ILS course to compensate for any instrument errors observed during ground check.

Horizon Deviation Indicator

The HDI needle tolerances in DEV mode are the same as the CDI bar tolerances given above. While the HDI does not have the "dot" displacement calibration, full-scale needle displacement on the HDI is 5°, while full-scale displacement of the CDI bar is 10°.

NAVIGATION

Weather Radar

Except when in system TEST position or when system is in STBY position for warm-up, do not operate radar:

- during fueling;
- within 100 feet of fueling operation or fuel spills;
- in the vicinity of trucks or containers holding flammable or exposive material;
- in a hangar or other enclosure;
- in congested ramp areas; or
- at any position where beam will "strike" large metal objects or buildings. Radar system damage may result.

Do not bring photo flash bulbs near an operating set. Flash bulbs can be exploded by radar energy.

AUTO FLIGHT SYSTEM

AUTOPILOT

Limiting Speed for Use of Autopilot:

Vmo/Mmo **(AFM)**

Minimum Altitude for Use of Autopilot:

The autopilot may only be used at and about the following altitudes above the terrain:

DURING ENROUTE CRUISE (CLIMB AND DESCENT): 1,000 feet.

DURING APPROACH:

- ILS Automatic (Coupled) Approach: IFR Weather Conditions: 100 feet.
  VFR Weather Conditions: 50 feet.

- All approaches other than ILS Automatic (Coupled) Approach: 50 feet below minimum ceiling authorized for the facility being used.

General Autopilot Limits: (AFM)

- Altitude hold must be disengaged in severe turbulence.

- If autopilot automatic trim is known to be inoperative, autopilot must be disengaged and autopilot master switch must be turned OFF.

- If autopilot disengages during a "coupled" approach after glideslope lock-on, the autopilot must not be re-engaged during that approach.

- During "coupled" approaches, pilot must be ready to revert to manual control (keeping one hand on the controls), and must monitor approach by reference to HDI and CDI or by visual reference.

Altitude Loss Caused by Autopilot During Pitch Channel Malfunction:

- LEVEL FLIGHT: 500 feet **(AFM)**

- ILS "COUPLED" APPROACH: 20 feet **(AFM)**

Autopilot Yaw Damper: (AFM)

Autopilot yaw damper must be disengaged prior to touchdown.

Engine-out Approaches:

Engine-out approaches with the autopilot engaged are not permitted.

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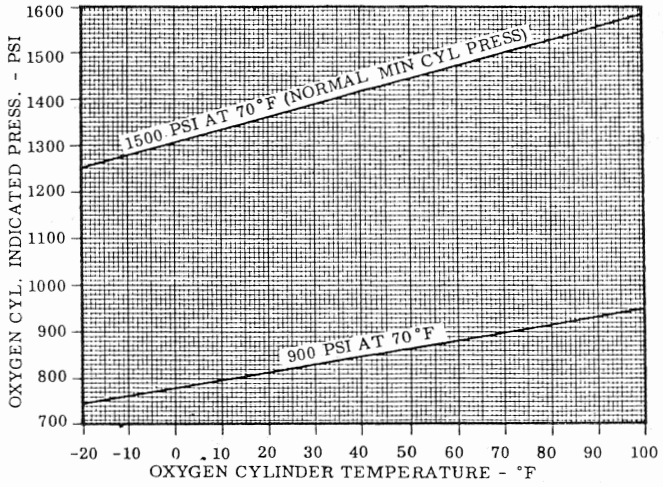
OXYGEN

OXYGEN CYLINDER PRESSURE REQUIREMENTS

Minimum oxygen pressure is 1,500 PSI and 9,000 PSI at a cylinder temperature of 70°F. Use the following chart to determine the minimum oxygen pressure at other than 70°F. Ambient temperature should be used in determining the minimum cockpit and cabin cylinder pressure.

PRESSURE VERSUS TEMPERATURE



DURATION - COCKPIT SYSTEM

Based on cylinder pressure of 1,500 PSI, the approximate duration of cockpit oxygen supply for continuous use by two cockpit occupants is as follows:

CABIN ALTITUDE (Feet)	DILUTER LEVER SETTING	APPROXIMATE DURATION
SEA LEVEL	NORMAL	2 hours 12 minutes
	100%	39 minutes
10,000	NORMAL	3 hours 5 minutes
	100%	1 hour
15,000	NORMAL	3 hours 55 minutes
	100%	1 hour 10 minutes
20,000	NORMAL	3 hours 30 minutes
	100%	1 hour 40 minutes
25,000	NORMAL	2 hours 50 minutes
	100%	2 hours

Based on cylinder pressure of 1,500 PSI, the approximate duration of the cockpit oxygen system, with the Emergency Levers on the two regulators in the ON position is 7 minutes.

(cont'd.)

OXYGEN

DURATION - CABIN SYSTEM

Based on a cylinder pressure of 1,500 PSI, the cabin oxygen system will provide the following:

- Emergency oxygen pressure to 84 passenger masks and for two cabin attentants for about 6-1/2 minutes.

OR

- Normal oxygen pressure to 84 passenger masks and for two cabin attendants for about 14-1/2 minutes.

OR

- Therapeutic oxygen to 10 persons for 1 hour and 30 minutes.

DURATION - PORTABLE BOTTLES

Cockpit Portable Bottles

Duration is based on 1,500 PSI cylinder pressure using attached demand mask. Duration will vary with degree of activity.

CABIN ALTITUDE	APPROXIMATE DURATION
Sea Level	14 minutes
10,000	21 minutes
15,000	26 minutes
20,000	33 minutes
25,000	43 minutes

Cabin Portable Bottles:

Based on 1,500 PSI cylinder pressure and using attached constant flow masks, duration varies from 20 minutes at sea level to 23 minutes at 20,000 feet and above.

(cont'd.)

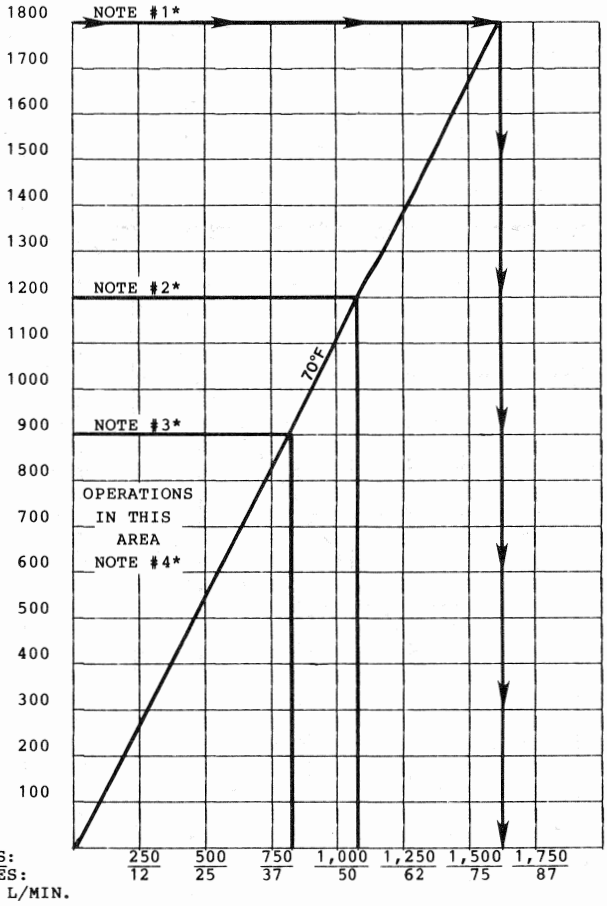
OXYGEN

COCKPIT OXYGEN SYSTEM

COCKPIT OXYGEN BOTTLE = 1,870 LITER @1,800 PSI/70°F

A. USABLE OXYGEN AT 1,800 PSI = 1,610 LITERS

B. CONSUMPTION OF OXYGEN PER CREWMEMBER = 10 LITERS/MINUTE



*NOTES are displayed on page 2-75-5 in this section.

OXYGEN

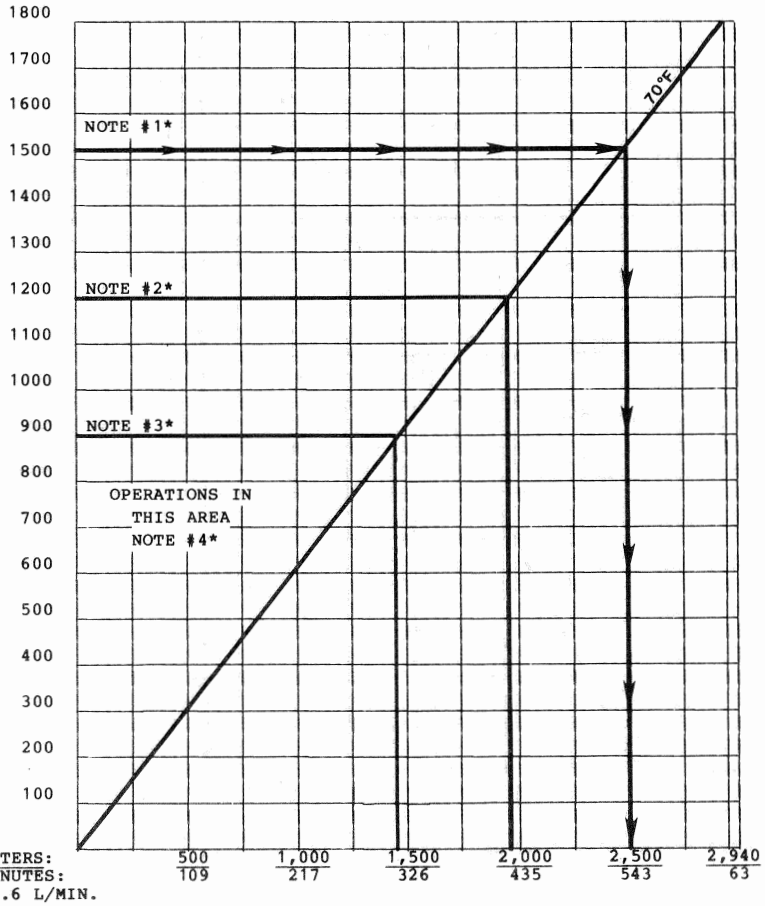
CABIN OXYGEN SYSTEM

PASSENGER OXYGEN BOTTLE = 3,200 LITERS @1,800 PSI/70°F

A. USABLE OXYGEN AT 1,800 PSI = 2,940 LITERS

B. CONSUMPTION OF OXYGEN PER PASSENGER AT 20,000 FEET (EMERGENCY FLOW)= 4.6 LITERS/MINUTE.

C. CONSUMPTION OF OXYGEN PER PASSENGER BELOW 17,000 FEET (NORMAL FLOW)= 2.3 LITERS/MINUTE.



*NOTES are displayed on page 2-75-5 in this section.

OXYGEN

NOTE #1:

Cockpit Example:

Based on 20 LITERS/MINUTE flow for two-man crew:

1,800 PSI @70°F = $\frac{1,610 \text{ LITERS}}{80 \text{ MINUTES}}$

Cabin Example:

Based on MAXIMUM OXYGEN flow:

1,530 PSI @70°F $\frac{2,500 \text{ LITERS}}{543 \text{ TOTAL MINUTES}}$

$\frac{543 \text{ TOTAL MINUTES}}{26 \text{ TOTAL PASSENGERS}}$ = 21 MINUTES OXYGEN

NOTE #2: 1,200 PSI @70°F Minimum Maintenance Dispatch Pressure.

NOTE #3: 900 PSI @70°F Minimum Pressure Authorized Without Operations Approval.

NOTE #4: In the event Minimum Dispatch Pressure of 900 PSI cannot be met, the crew will make the following considerations:

- Number of Passengers
- Enroute Terrain
- Weather
- Length of Flight
- The crew will not operate the aircraft at flight levels above FL250, unless at least a 10-minute supply of supplemental oxygen, in addition to other oxygen requirements prescribed by the Company in the interest of safety are satisfied.
- Operations approval has been obtained.

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POWERPLANT

INSTRUMENT MARKINGS:

- RED RADIAL: Maximum and Minimum Limits
- YELLOW ARC: Precautionary Ranges
- GREEN ARC: Normal Operating Ranges

RATING LIMITS (RPM, EGT)

OPERATING CONDITION	N1 % RPM	N2 % RPM	EGT °C	TIME	NOTE REFERENCES
Starting (AFM)	---	---	570	2 seconds	(1) & (2)
Ground Idle	---	62.0	540	Continuous	
Takeoff (511) (AFM)	106.6	100.1	580	5 minutes	(3) & (5)
Climb	105.0	94.0	480	Continuous	
Cruise	105.0	93.0	465	Continuous	(6)
Max. Cont. (AFM)	106.6	98.1	540	Continuous	(7)
Reverse (Normal)	105.0	90.0	420	30 seconds	(4)
Reverse (Maximum) (AFM)	106.6	100.1	580	30 seconds	(3) & (5)

NOTE REFERENCES:

1) Start Overtemp: A starting peak of 570°C is allowed for no longer than 2 seconds. If 570°C is exceeded, shut down engine and enter peak EGT and estimated time at that peak in the log book.

2) Peak EGT During Start: Peak EGT should not exceed 500°C, unless indicated fuel temperature is above 30°C. If peak EGT exceeds 500°C with fuel temperature of less than 30°C, enter peak start EGT and fuel temperature in the log book.

3) Overtemp During Takeoff and Reversing: EGT greater than 580°C, but not exceeding 590°C is permissible for periods not longer than 20 seconds. If EGT remains above 580°C for more than 20 seconds or exceeds 590°C for any period, retard throttle immediately.

4) Normal Reverse Detent: Reverse RPM's above the 90% N2 detent should not normally be used. However, if necessary, full reverse capabilities may be obtained by overriding the detent. If full reverse is used, make a log book entry.

5) Overspeed (AFM): Overspeed is defined as 106.6% N1 and/or 100.1% N2 exceeded for more than 20 seconds. 110.0% N1 and/or 103.1% N2 exceeded for any period. If overspeed occurs, shut down engine if operating conditions permit. Enter all cases of engine overspeed or overtemperature in the log book, giving maximum observed RPM or EGT and time at that peak.

6) Set throttles to give synchronized N1 during cruise when engines are operated at 465°C EGT.

7) When using maximum continuous power, make entry in the log book including duration of its usage.

(cont'd.)

POWERPLANT

GROUND IDLE RPM: (AFM)

N2 must be between 58% and 62%.

REVERSE THRUST: (AFM)

NOTE: See Rating Limits (RPM, EGT) Table in this section.

- Reverse thrust shall not be selected in flight.

- Total time in reverse must not exceed one minute; 30 seconds of which may be at power above reverse idle.

VIBRATION:

STARTING: 4.5 Units
CRUISE: 3.0 Units

If vibration level exceeds 4.5 units during start:

Shut down engine IMMEDIATELY.

If vibration level exceeds 3.0 units in flight:

Shut down engine, if operating conditions permit.

If engine shut down is not practicable:

Attempt to operate engine at an RPM where vibration level is the lowest, monitoring the other engine instruments.

OIL PRESSURE:

Maximum:

As such, there is no maximum oil pressure limit; however, oil pressure should not normally exceed 55 PSI at maximum continuous power.

Minimum: (AFM)

- TAKEOFF AT N2: 35 PSI

- IN FLIGHT AT:

  - 98.1% N2: 30 PSI
  - 92.0% N2: 26 PSI
  - 84.0% N2: 22 PSI
  - 72.0% N2: 17 PSI

- GROUND IDLE AT 60.0% N2: 16 PSI.

If oil pressure falls below the appropriate value given above, shut down the engine.

(cont'd.)

POWERPLANT

OIL TEMPERATURE: (AFM)

MAXIMUM FOR CONTINUOUS OPERATION:	100°C
MAXIMUM FOR 15 MINUTES:	120°C
MINIMUM FOR STARTING:	-40°C
MINIMUM FOR OPERATION ABOVE IDLE:	-30°C

OIL CONSUMPTION:

Maximum oil consumption is 2.5 pints per hour on each engine. However, before changing an engine for reported high consumption, Maintenance may request vertification of consumption by additional flights.

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GENERAL LIMITATIONS

CHINE TIRES: (AFM)

Chine tires must be installed on the nose wheels to permit takeoffs in standing water or slush.

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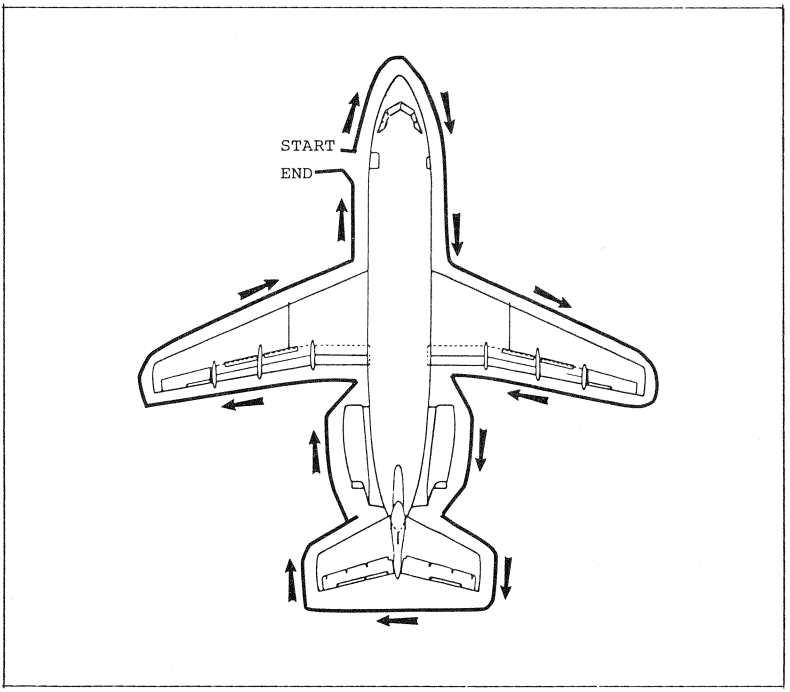
PREFLIGHT INSPECTION

INSPECTION ROUTE



RECEIVING AIRCRAFT

At originating stations, crew change points, or when resuming an interrupted flight, a walk-around inspection should be made. While checking specific items note the general, overall appearance of the aircraft for damage and indications of defective, maladjusted, or insecure installation. The cockpit and interior inspection is normally performed by the Captain and the exterior inspection is normally performed by the First Officer unless otherwise instructed by the Captain.

PREFLIGHT INSPECTION

INTERIOR INSPECTION

As the aircraft is boarded, the general condition of all cabin and cockpit areas should be noted as well as specific items, especially those emergency items in the cockpit. All items of emergency equipment contained on the Emergency Equipment & Exit Location diagram in this chapter should be onboard and in their assigned location.

Flight Attendants shall check extinguishers, portable oxygen, and other emergency items located in the passenger cabin.

Briefly check condition of doors and windows, including emergency exits, throughout the aircraft. Check tops of wings through windows for condition, loose caps or panels, and the main wheel indicators. Check flap position tape markings agree with flap handle/indicator.

In the companionway, in addition to emergency equipment, the following items should be checked:

- Spare bulb supply.

- Circuit Breakers.

- If APU is operating, check pressurization amplifier, no red light illuminated; nosewheel position indicator, 75% of lighted green circle should be visible.

- If APU is not operating, return to companionway and check the pressurization amplifier and nosewheel position indicator after starting APU.

EXTERIOR INSPECTION

The following checks are performed prior to and/or during exterior inspection. Many of the following due to location may be more easily checked prior to being seated.

While checking specific items, note the general overall appearance of the aircraft for indications of defective or insecure installation or closure, duct blockage, damage, etc.

Discharge and Safety Valves - Discharge valve should be open and both valves should be free from blockage, if AC power is on aircraft.

Left Pitot and Static Ports - Secure and free from blockage.

Ice Detector (Hot Rod) - Secured.

Nose Light - Retracted and lamp intact.

Electric Bay Door - Secured.

(cont'd.)

PREFLIGHT INSPECTION

EXTERIOR INSPECTION (cont'd.)

Nose Gear - Check the general security of the nose gear mechanism insuring doors are secured up. Check to see that tires are properly installed with chines facing outward and that tires are not worn out beyond limits. (If the three center grooves are not discernible and cord is showing, tire must be changed.) Check to see that static bonding wires are intact; if not, should be corrected not later than following RON.

Right Pitot and Static Ports - Secure and free from blockage.

Right Stall Ident and Shaker Vanes - Free from damage. (Vanes may be situated in various positions. This is normal. However, they must not in any way be bent, chipped, or cracked.)

Right Middle Statics - Free from blockage.

Right Wing Inspection Light - Clear and intact.

Right Heat Exchanger Intake - Free from blockage.

Right Main Gear - Doors secured. Check for worn tires. (If cord is showing, Maintenance must be notified.) Forward brake wear pin. (If pin is flush, brake must be brought to the attention of the Captain and Maintenance.)

NOTE: Brake wear is checked with parking brake applied.

Right Wing and Leading Edge - No damage or erosion to wing or leading edge. Fuel leaks: Notify Maintenance for evaluation.

Right Wing Tip - Check for damage to wing tip, high intensity lights and green navigation light. Check that static wicks are intact. There are 18 static wicks installed on the aircraft; 12 are required and one static wick must be intact at wing and tail outer extremity.

Right Aileron and Flap - Check for damage. Aileron trim bonding wire secure.

Right Aft Brake Wear Pin - Same limitation as forward brake pin.

Right Hydraulic Drains - No excessive fluid run out (continuous).

Right Engine Intake and Cowl - Free from damage and blockage.

Right Stub Wing Area - Access panels flush. Pneumatic relief valve flush.

External APU Fire Control Panel - Switches normal. Indicators clear in color.

APU Fire Extinguisher Thermal Relief Discs - Secured.

APU Inlets - Free from blockage. Check for scorching.

Right Feel Pitot and Statics - Secured and free from blockage.

(cont'd.)

PREFLIGHT INSPECTION

EXTERIOR INSPECTION (cont'd.)

Tailplane Position (Left Side) Elevator Trim Tab Flush, Rudder - No damage to white navigation light.

NOTE: If bulb is out, select LOWER position with switch located on F/A's panel in rear of aircraft.

Ventral Stairs - Secured.

CAUTION: For emergency ingress/egress of the aircraft, unlock external pull handle. (Should be locked from the previous day.)

Left Feel Pitot and Statics - Secure and free from blockage.

APU Fuel Line Fairing - Free from damage and fuel leaks.

Left Stub Wing Area - Access panels flush. Pneumatic relief valve flush.

Engine Fire Extinguisher Thermal Relief Discs - Secured.

Left Engine Intake and Cowl - Free from damage and blockage.

Left Engine Inspection Light - Clear and intact.

Left Hydraulic Drains - No excessive fluid run out (continuous).

Left Aft Brake Wear Pin - Same limitations as forward brake pin.

Left Aileron and Flap - Check for damage. Aileron trim bonding wire secure.

Left Wing Tip - Check for damage to wing tip, high intensity lights and red navigation light. Check that static wicks are intact. There are 18 static wicks installed on the aircraft; 12 are required and one static wick must be intact at wing and tail outer extremity.

Anti-Collision Lights - Check that upper and lower rotating beacons are intact.

Left Wing and Leading Edge - No damage or erosion to wing or leading edge. Fuel leaks: Notify Maintenance for evaluation.

Left Main Gear - Doors secured. Check for worn tires. (If cord is showing, Maintenance must be notified.) Forward and rear brake wear pins. (If pin is flush, brake must be brought to the attention of the Captain and Maintenance.)

Note: Brake wear is checked with parking brake applied.

Left Heat Exchanger Intake - Free from blockage.

Left Wing Inspection Light - Clear and intact.

Left Middle Statics - Free from blockage.

Left Stall Ident and Shaker Vanes - Free from damage. (Vanes may be situated in various positions. This is normal. However, they must not in any way be bent, chipped, or cracked.)

(cont'd.)

PREFLIGHT INSPECTION

EXTERIOR INSPECTION (cont'd.)

Gear Pins - STOWED. Check that gear pins are on board in the forward cargo hold. Also check the umbilical cord is on board in the same area.

Forward Entrance Door and Stairs - Check for security at railings, steps and stairway track.

LEFT BLANK INTENTIONALLY

CHECKLIST AMPLIFICATION

GENERAL

Normal cockpit checks and operating procedures presented in detail on the following pages coincide with the checklist in the cockpit. In this expanded presentation of the checklist, the **CHALLENGE** portion is underlined, and the **RESPONSE** is **CAPITALIZED**, and detailed explanation follows, as necessary. The Originating Checklist is read by the First Officer and responded to by the Captain, First Officer, or both as appropriate. Generally the inflight CHALLENGE portion of the checklist should be read by the pilot not flying, the item checked and the RESPONSE made by the appropriate pilot. Pilots shall cross-check each other as much as possible to determine that each item is checked or accomplished properly. Both the CHALLENGE and RESPONSE of the After Takeoff checklist may be accomplished by the pilot not flying. The After Landing checklist may be accomplished by the pilot not taxiing, and the Parking and Securing checklist may be accomplished by either pilot.

All items (margin and indented) on the Originating (Receiving the Aircraft) side of the checklist shall be accomplished at the originating station on the aircraft's first flight of the day. All items, above and below the line, on the Parking and Securing checklist shall be accomplished at aircraft termination. When a flight crew change occurs, only the Intermediate items on the Originating Checklist (those items flush with the left margin) need be accomplished.

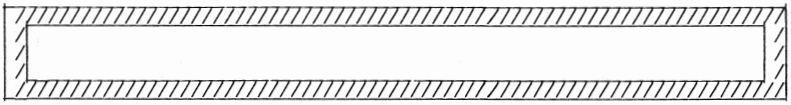
Where applicable and appropriate, checklist amplification is interrupted to spell out particular procedures and/or policies in detail. As much as is possible, continuity is maintained from the start of a flight to its completion.

The Normal checklist does not cover all the necessary normal procedures to be performed. Instead, it is a double-check on important items during the more critical phases of the operation. The flight crew shall accomplish the various procedures as necessary and use the checklist as a true double-check. For example, items on the Originating checklist which require a significant amount of time to accomplish can be done prior to reading the checklist, then answered to as it is read. Actually, the entire Originating checklist can be accomplished in this manner, if desired.

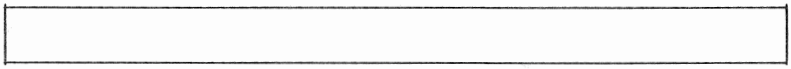
It will be noted that detailed checks of various units such as the autopilot, flight directors, and NAV/COMM radios, etc., are included in the amplification for use where desired. Checks should always be as complete as pilots determine are necessary to insure proper operation.

CHECKLIST AMPLIFICATION

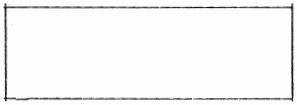
Checklist Emergency/Abnormal and Normal titles are contained in this type box:



Procedural titles are contained in this type box:



Procedural steps in the flow pattern of a particular procedure may or may not be contained in this type box:



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COCKPIT CHECKLIST
NORMAL PROCEDURES
BAC 1-11 (400)

ORIGINATING & INTERMEDIATE (Receiving Aircraft)

CHECK ALL MARGIN AND INDENTED ITEMS FIRST FLIGHT OF DAY; ONLY MARGIN INTERMEDIATE ITEMS NEED BE CHECKED WITH FLIGHT CREW CHANGE.

Pre-Flight Inspection ---------- COMPLETED
Log Book, Forms, Manuals ---------- CHECKED
Circuit Breaker Panels ---------- CHECKED
  Battery ---------- ON/CHECKED
Standby Steer L.P. Light ---------- TEST/OUT
Static Inverter ---------- CHECKED
Fire Warnings/Discharge Indicators ---------- TEST/CHECK
APU or Ground Power ---------- AS REQUIRED
  Electrical Panel ---------- CHECKED
  Fuel Panels/Gauges ---------- CHECKED
  Pneumatic/Air Conditioning Panels ---------- CHECKED/SET
  Passenger Oxygen Panel ---------- CHECKED
Emergency Lights ---------- ARM
Door Warnings ---------- TEST
  Radio Cooling Fan/Flight Recorder/Voice Recorder ------ TEST/OUT
  Seat Belt/No Smoking ---------- AS REQUIRED
  Beacon/Nav/Service Lights ---------- AS REQUIRED
  Ice Protection Panels ---------- OFF
  Windshield Heat ---------- LOW/ON/TEST LIGHTS
  Pitot Heat ---------- TEST/AS REQUIRED
  Landing/Taxi Lights ---------- AS REQUIRED
  High Speed Warning ---------- TEST
  Hydraulic Panel ---------- TEST LIGHTS/QTY/ENG PUMPS ON
Parking Brake ---------- CHECKED/AS REQUIRED
  No. 1 AC Hydraulic Pump ---------- ON/CHECK PRESSURE
  Flight Controls/Stall Systems ---------- CHECKED
  No. 1 AC Hydraulic Pump ---------- OFF
  No. 2 AC Hydraulic Pump ---------- ON/CHECK PRESSURE
  Flight Controls/Autopilot ---------- CHECKED
  Yaw Damper ---------- ON/TEST
  No. 2 AC Hydraulic Pump ---------- OFF
  Trim Tabs ---------- 4 CHECKED & SET
  Flying Control Cutoff Levers ---------- OFF
  Emergency Elevator ---------- ON/CHECK/OFF
  Flying Control Cutoff Levers ---------- ON/CHECK LIGHTS & IND
  Throttles ---------- FREE/HORN/CLOSED
  HP Fuel Valves ---------- SHUT
  Flaps ---------- AS DESIRED/CHECK IND
  Mach Trim ---------- ON/TEST LIGHT
  TTC/Fuel Dip ---------- TTC ONLY
  Radios/Radar/Transponder/GPWS ---------- CHECK/SET
  Flight Director/Inst./Switching ---------- CHECK
  Static Selectors/Switching ---------- NORMAL
  Engine Overheat Warning ---------- TEST/OUT
  TVI ---------- TEST
  Reverse/Flap Shaft Fail Lights ---------- TEST
  Center Instrument Panel ---------- CHECKED
  Oil Pressure Lights ---------- TEST/ARMED
  Anti-Skid ---------- TEST/OFF
  Landing Gear Lights/Horn ---------- ON/TEST
  Ram Air Valve ---------- CLOSED
  Cabin Pressure Panel ---------- SAFETY VALVE OPEN/SET ALT/LIGHT
  Discharge Valve ---------- OPEN/MAN CONT CLOSED
Oxygen/Masks/Interphone ---------- CHECKED
  Fuel Jettison Panel ---------- OFF/COVER DOWN
  Emergency Gear Handle ---------- STOWED
Takeoff Data ---------- POSTED/CHECKED
  Airspeed Command Bugs ---------- SET

BAC 1-11 BAC 1-11 BAC 1-11 BAC 1-11 BAC 1-11

BAC 1-11 (400)
COCKPIT CHECKLIST
NORMAL PROCEDURES

BEFORE START

Parking Brake ------ SET/CHECK PRESSURE
INS ---------- NAV
Battery Switch ---------- ON
Generators ---------- TRIP
Booster Pumps ---------- 4-ON
Isolation Valves ---------- OPEN
MAC Valves ---------- CLOSED
Mains Pressure ---- CHECK (25 PSI MIN.)
Seat Belt/No Smoking ---------- ON
Door Warning Lights ---------- TEST/OUT
Navigation Lights ---------- AS REQ'D.
Beacons ---------- ON
Wing Lights/Wheel Well Lights ----- OFF
Engine and Wing Anti-Icing -------- OFF
Ignition ---------- HI/LOW
Start Master ---------- START

AFTER START

INS ---------- NAV
Start Master/Ignition --------- OFF/LOW
Elect. Panel --------- GEN. RESET/CHECK
Fuel Panels ---------- CHECK
MAC Valves/Temp. Controls ---- APU/AUTO
Air Crossfeed --------- OPEN/Check M.I.
Pitot/Windshield Heat ---------- ON/LOW
Master Warning ---------- ARMED
Hydraulic Panel ------- ENG PUMPS ON/AC
PUMPS OFF/CHECK PRESS/QTY
Pressurization ---------SET FOR TAKEOFF
Safety Valve ---------- CLOSED
Anti-Skid ---------- OFF

TAXI CHECK

Brakes & Steering ---------- CHECKED
Speed Brakes ---------- FWD/COLLAR UP
Flaps ---------- SET FOR TAKEOFF
Trim ---------- (3) SET FOR TAKEOFF
Reversers ---------- CHECKED/LIGHTS OUT
Flt. Instruments/Directors- CHECKED/SET
Takeoff Data ---------- SET/CROSS-CHECK
Airspeed Command Bugs ------- CHECK/SET
Eng. Anti-ice ------- CHECK/AS REQUIRED
APU ---------- AS REQUIRED
Side Windows ---------- LOCKED

BEFORE TAKEOFF

Shoulder Harness ---------- FASTENED
Controls ---------- FREE
Standby-Horizon ---------- CHECKED
Anti-skid/Brake Temp. -------- ON/CHECK
#1 Aux. Hyd. Pump ---------- ON
Transponder ---------- ON
Landing Lights ---------- ON
Anti-Collision Lights ---------- ON
Ignitors --------- RELIGHT/CHECK LIGHTS

AFTER TAKEOFF

Gear/Flaps ---------- UP
Hand Brake Press ---------- ZERO
#1 Aux. Hyd. Pump ----- OFF/CHECK PRESS
Speed Brake Collar ---------- DOWN
Fuel Dip/TTC ---------- ARMED BOTH
Icing Systems/Ignitors ---- AS REQUIRED
Air Conditioning Panel ---- CHANGEOVER/
CROSSFEED CLOSED (CHECK M.I.)
APU ---------- AS REQUIRED
Pressurization ---------- CHECK
Fuel Transfer ---------- AS REQUIRED
Seat Belt/No Smoking ------ AS REQUIRED
Landing Lights ---------- OFF/RETRACTED

DESCENT

Pressurization ---------- SET
Circuit Breakers ---------- CHECKED
Landing Data & Bugs --------- CHECK/SET

IN RANGE

Fuel Panels ---------- SET
Altimeters ---------- SET/CROSS-CHECK
Hand Brake ---------- OFF
Accumulators ---------- PRESSURE CHECK
Fuel Dip/TTC ---------- TTC ONLY
Pressurization ---------- SET LANDING
Landing Lights ---------- 10,000 FT./ON

BEFORE LANDING

Shoulder Harness ---------- FASTENED
Anti-Ice Systems ---------- AS REQUIRED
Speed Brake ---------- FWD/COLLAR UP
Seat Belt/No Smoking ---------- ON
Landing Gear ------- DOWN-3 GREEN-PRESS
Anti-Skid ---------- ON/CHECK
#1 Aux. Hyd. Pump ---------- ON
Hyd. Press & Quantity ---------- CHECK
Flaps ---------- LANDING
Ignitors --------- RELIGHT/CHECK LIGHTS

AFTER LANDING

Radar/Transponder ---------- STANDBY
Flaps ---------- AS REQUIRED
Trim/TPI ---------- RESET/+2
Speed Brake/Anti-Skid --------- FWD/OFF
Safety-Discharge Valve ---------- OPEN
#1 Aux. Hyd. Pump -- OFF/CHECK PRESSURE
Anti-Collision Lights ---------- OFF
Anti-Ice ---------- OFF
Ignitors ----------OFF/HI/LOW
Windshield Heat ---------- AS REQUIRED
Pitot Heat ---------- OFF
APU/Air Cond ---------- AS REQUIRED
Landing Lights ---------- OFF

SHUT DOWN

Park Brakes or Chocks ----- AS REQUIRED
Air X-Feed & Del. Valve -------- CLOSED
MAC Valves ---------- APU
Fuel Pumps ---------- OFF
INS ---------- OFF
Emergency Lights ---------- OFF
Crew Oxygen ---------- OFF
Ground Cooling Fan -------- AS REQUIRED
APU ---------- OFF

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT

Preflight Inspection - COMPLETED. To be accomplished by both pilots, if possible; otherwise, the Captain may designate the duty or accomplish it himself/herself.

Log Book, Forms, Manual - CHECKED. The log book should be onboard and all items reviewed and checked as appropriate. The FAA-Approved Flight Manual and cockpit checklist should also be onboard.

Circuit Breaker Panels - CHECKED.

Battery - ON/CHECKED. Put load on battery by operating DC hydraulic pump. Battery voltage should be at least 21 volts.

Standby Steering Low Pressure Light - TEST/OUT. Press-to-test and light extinguished. If light remains illuminated, install nose gear down lock prior to pressurizing hydraulic system No. 1

Static Inverter - CHECKED. Select and read ESS AC bus; white flood lights BRIGHT; 115 volts/400 CPS. If APU is operating, accomplish the following:

- Check static inverter test switch and annunciator. The test switch interrupts the ground for the AC changeover relay, allowing the static inverter to supply power to the ESS AC bus. Voltage and frequency can be read with the selector switch in ESS AC bus position.

- Turn white flood lights to BRIGHT. Check eyebrow light over airspeed indicator, which will become airspeed indicator flood light on ESS power.

- Check Captain's gyro horizon erected, RMDI operative.

- Check third attitude horizon; observe flag disappears and background light illuminates.

- Perform third attitude horizon operational check. Wait a few seconds for the gyro to come up to speed, then pull the PULL TO ENGAGE KNOB firmly through both stops and release rapidly to the NORMAL position.

Fire Warnings/Discharge Indicators - TEST/CHECK.

- Check engine and APU fire handles in and aligned.

- Pull fire bell isolation light and observe light illuminated.

- Depress the three fire test switches. Observe all lights in the three fire handles function properly.

- Push fire bell isolation light. Light should extinguish.

- Depress each of the three fire test switches separately. The fire bell should ring each time.

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT
(cont'd.)

APU or Ground Power - AS REQUIRED.

GROUND POWER

Observe that white light is illuminated and check voltage and frequency on electrical panel prior to coupling. Limits: 115 ± 5 volts, 400 ± 8 CPS.

NOTE: If a voltage or frequency adjustment to the GPU is necessary, external power should be disconnected from the aircraft while the adjustment is being made. Check voltage and frequency before connecting to the aircraft system.

APU

Check voltage 115 ± 5 volts, frequency 400 ± 8 CPS.

NOTE: Restrict the use of the APU to necessary operations ONLY. For example, at the ramp prior to departure, taxi-out, takeoff, just prior to ramp arrival, and abnormal or emergency situations.

IF APU NOT OPERATING

- Check KVA meter reads ZERO.
- Check generator control switch in NORMAL.
- Check air delivery valve CLOSED.
- Place start master switch to APU, then APU control switch to ON. Observe that APU fuel valve is OPEN.
- Push start button. Observe start indicator shows START and changes to RUN. Check EGT rise and stabilization are within limits. Return start master switch to OFF or APU starter arm switch to OFF and fire warning switch to AUTO.

NOTE: Starter - Cool Cycle - one minute duration of start. After three one-minute attempts, cool starter for 30 minutes.

If unit fails to light within one minute, start indication remains:

- APU Control Switch - OFF. Observe fuel valve indicator CLOSED and start annunciator BLACK.
- Start Master Switch - OFF.

Under no circumstances may the start master switch remain selected to APU for more than two minutes after start indication.

- Reset generator if not on-line.
- Check voltage 115 ± 5 volts, frequency 400 ± 8 CPS.
- Check KVA meter indicating.

(cont'd.)

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT
(cont'd.)

APU or Ground Power - AS REQUIRED. (cont'd.)

IF APU NOT OPERATING (cont'd.)

- Check bus fail warning lights extinguished.
- Check TRU output, both indicating not above 60 AMPS per side.
- Check DC voltage not below 26 volts.
- Check DC fail light extinguished.
- If air delivery valve was CLOSED during APU check, OPEN.

Electrical Panel - CHECKED.

- All lights on the electrical panel should be checked for operation and pushed in.
- The CSDS DISCON/NORMAL switches must be positioned to NORMAL to start or motor engines.
- All warning lights should be checked for operation and functioning.

NOTE: Certain warning lamps incorporate a PUSH-PULL switch facility; e.g. fire bell isolate. It is possible to achieve an intermediate open circuit position unless care is taken to ensure that they are fully and positively operated.

Fuel Panels/Gauges - CHECKED. During refueling, do not operate switches in any electrical circuit having heat producing or arc-producing components outside the fuselage. In case of fuel or other combustible fluid spillage, do not operate any switch.

LONG RANGE TANKS (IF INSTALLED)

- Check long range fuel panel if fuselage tanks are to be used.
- Turn transfer valves to OPEN and check each tank pump by turning shutoff valves to OPEN and operating each pump.
- Observe T/R loads, if unable to OPEN transfer valves.
- Turn pumps OFF, shutoff valves CLOSED, and transfer valves CLOSED.
- Observe each pump's LP light during this check.
- Observe all red lights extinguished and press-to-test shutoff valve open warning light.
- Check all three tanks for proper quantity.

(cont'd.)

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT
(cont'd.)

Fuel Panels/Gauges - CHECKED. (cont'd.)

MAIN & CENTER TANKS

- Transfer Pumps/Valves - CHECKED/OFF/CLOSED.

  NOTE: Check of transfer pumps and valves is not required unless fuel is in the center or fuselage tanks. If the wing tanks are FULL, it will not be possible to check operation of the transfer valves because they will not open under this condition. In this case, the transfer valve operation should be checked after the engines are started.

- With the crossfeed CLOSED, turn left forward boost pump ON. Note left boost pump LP and engine low pressure lights extinguish, but right boost LP and right engine low pressure lights remain illuminated.

- OPEN crossfeed valve and note all boost pump LP lights extinguish.

- Turn left forward boost pump OFF and note all LP lights again illuminate.

- Turn remaining boost pumps ON, then OFF, one at a time. Observe that each extinguishes the red boost pump LP lights and the amber engine low pressure lights.

- Leave last boost pump switch ON. Turn LP fuel switches to CLOSE and check crossline. Turn LP fuel switches to OPEN and check in-line. CLOSE crossfeed. Observe opposite boost pump LP light and engine low pressure lights illuminate.

- Turn last boost pump OFF. Observe right boost pump LP light and right engine low pressure lights illuminate.

- Depress fuel gauge test buttons. Observe that quantity needles begin to decrease.

- Release button. Needles should return to original position. Check all three tanks for proper quantity.

- Check fuel quantity and distribution (8,000 lbs. minimum for dispatch and maximum allowable fuel imbalance for takeoff is 1,000 lbs.).

Pneumatic/Air Conditioning Panels - CHECKED/SET.

- Operate fuselage duct fail test button. Observe both system fail lights illuminate, then extinguish.

- Check No. 1 isolation valve is OPEN.

- Check No. 2 isolation valve is OPEN.

  NOTE: Both isolation valves should be OPEN.

(cont'd.)

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT (cont'd.)

Pneumatic/Air Conditioning Panels - CHECKED/SET. (cont'd.)

- Operate No. 2 system fail test button. Observe that respective stub duct and system fail light illuminate and remain illuminated. This test simulates a stub wing overheat. Operate system fail press-to-reset button. System fail light should extinguish.

- Operate No. 1 system fail test button. Observe that respective stub duct and system fail light illuminate and remain illuminated. This test simulates a stub wing overheat. Operate system fail press-to-reset button. System fail light should extinguish.

  NOTE: When either duct fail test button is depressed and the respective system fail light illuminates, the fail system lockout relay is latched, which simulates an actual system failure. This energizes the emergency-close portion of the isolation valve and pressure-reducing valve.

- Place No. 2 MAC valve to APU position.

- Place cabin temperature selector to MANUAL.

- Place flight deck temperature selector to MANUAL.

- OPEN air delivery valve and crossfeed valve. Check pressure.

- Place No. 2 MAC valve to APU position. It is desirable to operate only one air conditioning pack on-the-ground. This provides more efficient operation than two packs and does not overload the APU.

Passenger Oxygen Panel - CHECKED. With valves open, check pressures on right control and overhead panel. 1200 PSI minimum.

Emergency Lights - ARM. Emergency exit light over cockpit door will illuminate when in the ON position. Flight attendants can confirm cabin lights illuminated. Leave in the ARM position for automatic lighting with the opening of the DC split relay.

Door Warnings - TEST. Push-to-test. All lights will illuminate and extinguish if respective door is CLOSED and LOCKED.

Radio Cooling Fan/Flight Recorder/Voice Recorder - TEST/OUT. Press-to test radio cooling fan and light extinguishes. Press-to-test voice recorder and needle in the green. During the fuel panel check, observe flight recorder fail light extinguishes. With fail light illuminated, press flight recorder test switch and observe light extinguished.

Seat Belt/No Smoking - AS REQUIRED. Place to ON. Light operation can be checked by flight attendants.

Beacon/Nav/Service Lights - AS REQUIRED. The rotating anti-collision beacons should be turned ON prior to engine start and OFF after engine shutdown as a signal that engines are operating. They, and the oscillating or high intensity lights, should be ON at all times during flight.

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT
(cont'd.)

Ice Protection Panels - OFF.

- Engine heat switches both OFF, check gauges ZERO.

- Check OAT gauge against ambient temperature.

- Anti-icers may be checked briefly, avoiding full temperature rise.

- Ground check of anti-icing system, if required.

  CAUTION: Wing and tail anti-ice must not be operated continuously on the ground, regardless of ambient temperature.

- The following checks, No's. (2) and (3), may be made with APU bleed air. The MAC valves must be CLOSED. This check should be as brief as possible consistent with satisfactory indication of function. Check No. (1) can only be made with engine running, e.g., before first flight of the day, taxiing out.

  1) Move the No. 1 and No. 2 engine anti-icing switches to ON, check the pressure use, compare pressures, then switch both OFF.

  2) Move the No. 1 wing anti-icing switch to ON, check that the temperature rises, then move the switch to OFF. Repeat with the No. 2 switch. (Can use APU EGT rise, also.)

  3) Move the No. 1 tail anti-icing switch to ON, check that the temperature rises, then move the switch to OFF. Repeat with the No. 2 switch. (Can use APU EGT rise, also.)

     NOTE: A TEST position is installed on the wing and tail anti-ice system switches. This TEST position is used for checking the function of the anti-icing duct temperature bulbs. The switches are spring-loaded from TEST to OFF to prevent anti-icing system from being left ON inadvertently.

- Check ice inspection lights and hot rod.

Windshield Heat - LOW/ON/TEST LIGHTS. Check windshield overheat and underheat lights. Place windshield heat switch to LOW and side window heat switch to ON. If windows are cold-soaked, warm gradually by 10-second cycling between OFF and LOW for about one minute.

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT
(cont'd.)

Pitot Heat - TEST/AS REQUIRED. Check all pitot heaters. Turn switches ON. Check AMPS and that respective heaters fail lights extinguished. (Ammeter indication will peg, drop off to approximately 1/2 or 3/4 scale.)

NOTE: From left to right, the pitot heaters are P-5, P-3, P-4, P-1, and P-2. They extinguish heater fail lights as follows:

P-5 = NONE,
P-3 = No. 1 IDENT,
P-4 = No. 2 IDENT,
P-1 = No. 1 WARNING, and
P-2 = No. 2 WARNING.

Turn all five pitot heaters OFF after check.

During the above check of the pitot heaters after turning on P-1 and P-2, observe the left and right pitot heat failure warning lights are extinguished. The lights will illuminate after P-1 and P-2 are turned OFF. Inflight illumination of these lights constitutes a pitot heat emergency.

Landing/Taxi Lights - AS REQUIRED. Check all switches are either in the RETRACT or OFF position. If night operation, extend, check bulb operation, then return to RETRACT and OFF. It is desirable to leave all lights retracted when at the gate to prevent ground personnel from striking them due to their low proximity to the ground.

High Speed Warning - TEST.

Hydraulic Panel - TEST LIGHTS/QUANTITY/ENGINE PUMPS ON. Check each light for proper operation and each gauge for proper pressure and/or quantity. Position each switch for normal operation.

Parking Brake - CHECKED/AS REQUIRED. Pump hand brake a few times until hand accumulator falls slightly. Apply and lock hand brake. Check pressure approximately 3,000 PSI.

When the brake system has been pressurized, select DC pump and note rise in hand brake accumulator pressure. Top off system while making flight control check with No. 2 pump.

Set brake, chocks in place.

No. 1 AC Hydraulic pump - ON/CHECK PRESSURE. Observe when No. 1 AC pump is turned ON that the gust damper light extinguishes and pressure rises to 2,875 to 3,175 PSI.

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT
(cont'd.)

Flight Controls/Stall Systems - CHECKED.

FLIGHT CONTROLS

Check rudder, (hold steering wheel), elevator aileron/spoilers, lift dump operation. Check controls for power, freedom of movement, and full travel.

NOTE: Observe outboard spoilers when checking ailerons and check power on elevator.

Operate rudder trim 3° - 4° (hold steering wheel) in each direction and note rudder pedals follow. Operate TPI, leave at 0° and check gauge.

STALL SYSTEM CHECK

- Check right console.
- High pressure bottle 500 PSI minimum (500 to 1500 PSI normal).
- Low pressure bottle 57 ± 2 PSI.
- Check stall dump valve handle stowed.
- Operate No. 1 (Captain's) stall warning (shaker) switch.
- Operate No. 1 (Captain's) stall ident (push) switch, while maintaining pressure on the stall warning switch. Observe stickpush, valve A and B lights illuminate, amber stall ident light on instrument panel, and klaxon horn. Pilot should dampen control movement.
- Release pressure on stall warning switch; observe system fail light and pusher fail lights.
- Repeat for right No. 2 (F/O) system.
- Check operation of low pressure light.
- Select auto ignition No. 1. Observe one igniter on per engine.
- Select auto ignition No. 2. Observe one igniter on per engine.

No. 1 AC Hydraulic Pump - OFF. Bleed pressure to zero with elevators.

No. 2 AC Hydraulic Pump - ON/CHECK PRESSURE. When No. 2 AC pump is turned ON, observe that pressure rises to 2,875 to 3,175 PSI.

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT
(cont'd.)

Flight Controls/Autopilot - CHECKED.

FLIGHT CONTROLS

Check rudder operation, elevator, and ailerons/spoilers. Check controls for power, freedom of movement, and full travel. Check spoiler operation with speedbrake handle.

NOTE: Observe hydraulic pressure fluctuation when checking ailerons and spoilers; check power on elevator; check power on rudder and that pedals return to neutral.

Operate rudder trim 3° - 4° in each direction and note rudder pedals follow. Operate TPI, leave at 2° UP and check gauge.

AUTO PILOT

Select master switch to ON.

CAUTION: If autopilot master switch is inadvertently left OFF until in flight, autopilot should not normally be engaged. Instead, it is better practice to wait until after the next landing to turn the master switch ON, then use the autopilot on subsequent flights.

Engage the autopilot after a short warm-up. Disconnect with the button on the Captain's yoke.

Engage autopilot yaw damper. Disconnect with the button on the F/O's yoke.

Engage autopilot again. Manually disengage and observe flashing red lights. Extinguish with disconnect button on either yoke.

Engage the autopilot a fourth time. Gently apply rearward pressure on the control yoke and observe tailplane trim action. Apply further aft elevator pressure. Observe disconnect and flashing red lights. Extinguish with disconnect button on either yoke. This is a check of the torque limiter.

Set tailplane trim to 2°. Note indicator is in agreement.

Yaw Damper - ON/TEST. Check indicator initially swings right when button is depressed, and left when button is released.

No. 2 AC Hydraulic Pump - OFF.

Trim Tabs - 4 CHECKED & SET. Check freedom of aileron trim 3° to 4° in each direction, leave at zero or as positioned by inbound crew. Recheck TPI and rudder to be in desired positions. Check elevator trim in both directions. Set at zero and check indicator reading. Turn trim switch OFF.

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT
(cont'd.)

Flying Control Cutoff Levers - OFF. Check hydraulic cutoff levers and M.I. cross-line.

Move both cutoff levers to aft CUTOFF position.

Press-to-test LP and fail lights.

Emergency Elevator - ON/CHECK/OFF. Operate emergency elevator switch. Observe increased KVA load due to No. 2 AC pump operation. Observe amber elevator on light illuminated and flashing at Captain's and F/O's positions.

Move elevators. Note lightened load. Place emergency elevator switch to OFF. Note amber emergency elevator lights extinguished.

Flying Control Cutoff Levers - ON/CHECK LIGHTS & IND. Return levers to forward position while holding test button. Observe that lights illuminate when button is depressed and extinguish at approximately 1/4 of forward travel. M.I. in-line.

Throttles - FREE/HORN/CLOSED. Check each throttle separately for freedom of movement and that horn sounds well before the full-throttle position. Throttle should be fully closed for starting. This checks the takeoff warning horn. If flaps are extended, move speedbrake handle slightly aft, check throttles and horn, then put speedbrake handle full forward.

HP Fuel Valves - SHUT.

Flaps - AS DESIRED/CHECK INDICATOR. Indicator should agree with selector position and as observed by the walk-around.

Mach Trim - ON/TEST LIGHT. Place master switch to ON and activity light switch to A/P INTERLOCK and press-to-test light. On first flight of the day after Mach trim is in the parameters for activity, observe Mach trim light flashes at intervals as Mach increases. If on A/P, check light by selecting activity switch to FULL TIME, observe light and reselect A/P INTERLOCK.

In the event of a runaway, immediately restrain the tail trim wheel and set the Mach trim master switch to OFF.

TTC and Fuel Dip - TTC ONLY.

Radios/Radar/Transponder/GPWS - CHECK/SET.

RADIO CHECK/VHF NAVIGATION RECEIVERS

- After warm-up, select proper test frequency, if available.
- Turn the course selector on the course indicator to center the course deviation bar.
- With the TO-FROM arrow reading FROM, the selected course display should read 000°. With the arrow reading TO, the course window on the course indicator should read 180°.

(cont'd.)

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT (cont'd.)

Radios/Radar/Transponder/GPWS - CHECK/SET. (cont'd.)

RADIO CHECK/VHF NAVIGATION RECEIVERS (cont'd.)

- Where no test facility exists, the test switch may be used.

- If available, check the receiver against the local ILS frequency. Check warning flags on the course indicator and flight director for a workable signal, note displacement of the course bar (localizer indicator) when in GS mode, and the glideslope pointer on both instruments.

  NOTE: The G/S flag will show if aircraft is on the backcourse side of the ILS. If available, check the local DME transmission. Turn the VHF NAV receiver to the appropriate frequency and select DME ON. Bar lights for DME should be BLANK or in SEARCH. At lock-on, lights should indicate the correct distance to the station. Check aural identification. The DME identification signal is higher pitched and follows every fourth VOR identification.

ADF RECEIVER

- Turn the function switch to ANT, warm-up and tune in a strong local station.

- Switch to ADF, check RMDI pointer for proper bearing.

- Switch to LOOP, rotate needle left, then right. Return to ADF. Pointer should return to the original bearing. Return switch to ANT.

MARKER BEACON RECEIVER

- Turn receiver ON.

- Check before the first flight of the day.

VHF COMMUNICATIONS

- Tune each communications control head to a local station.

- Check each transmitter, receiver, and microphone. Check each headset and speaker.

- Check interphone and P.A.

RADAR CHECK

Place selector switch to STANDBY. Do not operate radar where antenna radiation might constitute a hazard. If there are no buildings or other large objects within 200 yards of the nose of the aircraft, ground operation of the radar is permitted.

(cont'd.)

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT
(cont'd.)

Radios/Radar/Transponder/GPWS - CHECK/SET. (cont'd.)

TRANSPONDER CHECK

- Place the function switch to STANDBY for immediate encoding to ATC after takeoff.

- For contingency purposes, e.g., electrical system deterioration, etc., operate No. 1 transponder for all flights. Operate No. 2 transponder for a 5-minute check on the high altitude enroute portion of a leg once a day.

GPWS CHECK

Manual self-test provides an operational preflight check of the GPWS. It is accomplished by depressing either forward instrument panel GPW FAIL/GPW TEST light caps. To complete the test, the following is required:

- Required electrical power must be on-line and both GPWS circuit breakers must be in.

- The radio altimeter must be operational, indicating less than approximately 5 feet and not FLAGGED out.

- The GPW FAIL/GPW TEST light caps must not be illuminated.

NOTE: The GPWS test can be accomplished on-the-ground ONLY.

To accomplish the GPWS preflight check, depress the GPW FAIL/GPW TEST light cap for 2 to 3 seconds and release. The following should occur for a satisfactory preflight check:

- The GPW FAIL/GPW TEST light cap will illuminate RED and remain illuminated for the complete check.

- The PULL UP warning light will illuminate RED followed by the sound "WHOOP - WHOOP", and the spoken command "PULL UP".

- At the completion of the pull-up cycle, the BELOW GS/GS INHIBIT light cap will illuminate AMBER followed by the spoken warning "GLIDESLOPE".

- At the completion of the glideslope cycle, the GPW FAIL/GPW TEST light cap will extinguish.

Flight Director/Instruments/Switching - CHECK.

FLIGHT DIRECTOR CHECK

A complete check will be made of each system. Ensure the operation of each control in all modes and note indications. Ensure operating power is on the flight director and all associated navigation equipment and all radios are turned ON.

(cont'd.)

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT
(cont'd.)

Flight Director/Instruments/Switching - CHECK. (cont'd.)

FLIGHT DIRECTOR CHECK (cont'd.)

- Tune NAV receiver to a local VOR frequency.

- Check vertical gyro erected and gyro compass slaved.

- Set mode selector switch to OFF. V-bars should be out-of-view.

- Place pitch command at zero and flight director indicator in HDG.

- The gyro, computer, and compass warning flags should disappear, the V-bars should appear, and the azimuth card should indicate magnetic heading under the lubber line.

- Set the heading marker under the lubber line in the course indicator. The V-bars should level. Vary the heading marker 10° on either side of the lubber line. V-bars should follow, calling for a bank in the appropriate direction.

- Move the pitch command knob throughout its range. V-bars should follow knob rotation, nose-up and nose-down. Reset pitch command to zero.

- Set mode selector to V/L. Rotate the course arrow until the lateral deviation bar centers and the TO-FROM pointer is toward the head of the course arrow. If the bearing is such that the course arrow is not under the lubber line when the lateral deviation bar centers, the V-bars should first call for a bank toward the course arrow setting and then, after a delay, come to rest level. Check V/L capture.

- If close to a localizer/glideslope signal, tune NAV receiver to localizer frequency. Rotate flight director indicator mode selector knob to GS.

  Set course arrow to inbound localizer front course. The course indicator deviation bar should show the localizer path in relation to the miniature aircraft on the instrument face. The runway symbol shutter on the flight director indicator should disappear; the localizer/runway symbol should indicate any existing deviation from the localizer.

  The glideslope pointer should be in-view. The GS warning flags may or may not appear. If the glideslope signal is insufficient, GS flags should appear. Return the course indicator and flight director indicator controls as required for forthcoming flight.

FLIGHT DIRECTOR SYSTEMS

Set mode selectors as required. All warning flags should be out-of-view. If the V-bar command indicator is not desired, the mode selector should be placed to OFF. The HDG mode may be used to present heading and pitch commands as set with the PITCH CMD and HDG knobs.

(cont'd.)

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT
(cont'd.)

Flight Director/Instruments/Switching - CHECK. (cont'd.)

SLIP INDICATORS

During taxi, the ball should be checked for proper response as required for forthcoming flight.

FLIGHT INSTRUMENTS AND SWITCHES

Set and cross-check instruments as follows:

- Airspeed - ZERO.
- HDI's - No gyro or computer flag. Pitch and bank zero. Set PITCH CMD. Set mode selector as desired.
- Radio Altimeter - Reset DH light and TEST as detailed later in this section.
- Standby Horizon - No flag. Check pitch trim zero and roll indicator centered.
- A/P and F/D Comparator Warning Annunciators - PRESS-TO-TEST.
- Captain's and F/O's Altimeters - Set local station pressure (QNH). Select STBY on Captain's altimeter, then NORM. Press-to-test Captain's altimeter. Altimeter will decrease by 500 feet.
- HDI and CDI Switches - CHECK/NORMAL.
- RMDI's - No flag/SET/Slaving.
- CDI's - No HDG Card Flag/Cross-check headings.
- IVSI'S - ZERO.
- Clocks - SET.
- Back/Front Switches - FRONT.
- RMI Mode Switches - SLAVED HDG.

ALTIMETERS CHECK

Set altimeters to current field barometric setting as given by FAA communications.

MAXIMUM ALTIMETER DEVIATION (FEET)		
Altitude (Feet)	Maximum Deviation (Feet) Each Instrument	Maximum Spread Between Both Altimeters (Temp. 74°F)
0 - 2000	-30 to +40	40 Feet

(cont'd.)

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT
(cont'd.)

ALTITUDE ALERTER OPERATIONAL CHECK

Set altitude alert altitude to same altitude as Captain's altimeter. Depress set knob and rotate slowly to increase altitude. At approximately 300 feet above Captain's altitude, the one second bleeper should sound and the amber light illuminate. Continue to rotate set knob until altitude alert altitude reads at least 1,000 feet above Captain's altimeter. Release knob and cancel light. Depress set knob again and rotate slowly to decrease altitude. When altitude alert altitude reads approximately 900 feet above Captain's altitude, bleeper should sound and warning light illuminate. Continue rotating set knob downward. At approximately 300 feet above Captain's altitude, light should extinguish.

RADIO ALTIMETER CHECK

Radio altimeter readout may vary considerably from barometric readouts because it is measuring actual height above terrain.

Testing one indicator checks the transmitter-receiver unit and both indicators on airplanes not equipped for overwater operations, (two T/R's).

- Depress D.H. lightcap.

- SET/TEST knobs (both) - ROTATE SLOWLY. Set bug below "0". Check that the DH light is illuminated while bug and counter are above "0". Rotate below "0" until light extinguishes.

- At this point, a check of the "aural" warning may be done by momentarily depressing the Captain's SET/TEST knob. (Captain's indicator is the only one that will arm the aural warning.) Depress the D.H. light cap once again. As the SET/TEST knob is slowly rotated in the next step, the "tempo" of warning will increase and stop as the D.H. reaches 0.

- SET/TEST knobs (both) - ROTATE SLOWLY to raise bug. As the bug passes through "0" DH light will illuminate. Set 100 feet in the counter window.

- SET/TEST knob (either) - DEPRESS. Check that the tape reads 100 $\pm$ 5 feet and yellow flag appears, bug should indicate 100 $\pm$ 5 feet. Set for departure.

PRIOR TO BEGINNING APPROACH:
Push SET/TEST knob as above.

Decision Height Bug - SET.

(cont'd.)

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT
(cont'd.)

Flight Director/Instruments/Switching - CHECK. (cont'd.)

RADIO ALTIMETER CHECK (cont'd.)

DESCENDING THROUGH 2500 FEET ABOVE TERRAIN:

- Check that Radio Altimeter tape shows movement and DH light illuminates.

DESCENDING THROUGH 1000 FEET ABOVE TERRAIN:

- Check DH light illuminated. Press light cap to extinguish.

Most radio altimeters have an aural alert at MDA/DH.

Refer to Chapter 14 - AUTO FLIGHT SYSTEM for the Radio Altimeter's affect on autopilot desensitization during coupled approaches.

Static Selectors/Switching - NORMAL. Check Captain's and F/O's switches NORMAL and guarded. Check Captain's backcourse, RMI (slaved HDG), GPWS inhibit and flap inhibit guards down. Check F/O's backcourse, RMI (slaved HDG) guards down. Normally, each pilot checks the opposite side.

Engine Overheat Warning - TEST/OUT. Depress each engine overheat light cap and check light illuminates. Actuate reset switch under each light and check light extinguishes. Actuate Zone 2 test switch and check both engine overheat lights illuminate, then release switch and check light extinguishes.

TVI - TEST. An engine vibration indicator for each engine shows a relative amplitude to the vibrator pick-up signal and is scaled from 1 to 5 units. A button on the instrument labeled HF PUSH causes the lower vibration frequencies to be filtered out permitting a check on the high speed rotor vibrations. A test button on the indicator is depressed to check the system. Simultaneously depressing the HF PUSH button tests the high frequency feature.

Reverse/Flap Shaft Fail Lights - TEST. Push-to-test; check amber lights illuminate.

Center Instrument Panel - CHECKED. Check engine instruments from top to bottom:

- Engine pressure (ambient pressure on P-7 gauge).
- HP RPM (zero rotation).
- EGT (ambient temperature).
- Full Flow (zero).
- Oil Temperature (ambient temperature). Temperature should be above -40°C for engine start and above -30°C to open throttle.
- Oil Pressure (zero).

Oil Pressure Lights - TEST/ARMED. Push each oil pressure low light IN.

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT (cont'd.)

Anti-skid - TEST/OFF. Select test switch to INBOARD, obtain two releases on outboards. Select OUTBOARD, obtain two releases on inboards. Respective lights (releases) should extinguish after switch is released. If a blank indicates RELEASE, anti-skid is inoperative.

Landing Gear Lights/Horn - ON/TEST. In addition to observing the gear handle down, it should be pressed in to establish that it is in the DOWN detent.

With the throttles closed, operate horn test switch, sounding horn. Operate to unsafe position, illuminating light. Check three green lights operating, red intransit light extinguished.

Ram Air Valve - CLOSED.

- Cabin Pressurization Panel - SAFETY VALVE OPEN/SET ALT./LIGHT.

- Check Data Plate forward of throttle quadrant:

- Set Barometric Correction knob to 29.92.

- Set Cabin Altitude knob according to Data Plate. In no case will cabin be set less than 500 feet above departing airport elevation.

- Set Rate of Climb knob to 12 o'clock position (500 FPM UP).

- In no case will the aircraft takeoff or land pressurized.

Discharge Valve - OPEN/MAN. CONT. CLOSED. This valve operation may be checked by the crew, if desired.

- To avoid possible damage to the linkage, operate the actuating wheel with the tip of the index finger.

- Depress and turn CCW to STOP, then return to first notch.

- Check the position indicator for OPEN.

Oxygen/Masks/Interphone - CHECKED.

- Open both flight deck and cabin supply valves. The flight deck valve should be OPEN at all times.

- Check system pressure at 1200 PSI for dispatch pressure.

- Both pilots select flow supply ON, 100% oxygen, and emergency OFF.

- Turn oxygen emergency selector to EMERGENCY position to check pressure flow and to purge mask. Return to OFF position.

(cont'd.)

ORIGINATING CHECKLIST - RECEIVING AIRCRAFT (cont'd.)

Oxygen/Masks/Interphone - CHECKED. (cont'd.)

- Each crewmember should done his/her oxygen mask, check oxygen flow, and establish communications on normal intercom, emergency intercom, or P.A.

- Return masks to holders, making sure mask straps are loosened to insure quick donning in an emergency.

- Set oxygen mask mike switch to NORMAL. Check and adjust goggles. Check third station panel supply ON. Check hand cradle set for P.A. and intercom and check operation in conjunction with F/A's intercom (2).

Fuel Jettison Panel - OFF/COVER DOWN. Check all four switches OFF and annunciators are cross-line. Check panel guard down. Compute dump rate if taking off over 78,000 lbs. Time to dump fuel from "rotate" gross weight to 78,000 lbs. should be based on a dump rate of 1,350 lbs. per minute total. Wing tanks terminate dumping automatically 2,500 lbs. per tank. The center tank can be emptied.

Emergency Gear Handle - STOWED. It is not necessary to raise hinged cover over this free-fall handle. If cover is in place, handle is in place.

NOTE: If handle is raised, investigate reason prior to stowing.

Takeoff Data - POSTED/CHECKED. (V1, Vr, V2, VFS Min. P7) and airspeed posted and checked.

Airspeed Command Bugs - SET.

GROSS WEIGHT	TAKEOFF						BSEC	MANEUVERING				LANDING		
	18° Flap			8° Flap			0°							
(lbs)	V1	Vr	V2	V1	Vr	V2	FLAP	0°	8°	18°	26°	45°	26°	0°
56,000	105	106	116	110	111	124	170	154	144	135	131	111	116	137
57,000	106	107	117	111	112	125	170	156	145	136	132	112	117	138
58,000	107	108	118	112	113	126	170	158	146	137	133	113	118	139
59,000	108	109	119	113	114	127	170	159	147	138	133	113	119	140
60,000	109	111	120	115	119	128	170	160	147	138	133	113	119	144
61,000	110	112	121	116	120	128	170	161	147	138	133	113	119	145
62,000	111	113	122	117	122	129	170	163	148	138	134	114	120	146
63,000	112	114	122	118	122	130	170	164	149	139	135	115	121	147
64,000	113	115	123	119	123	131	170	165	150	140	136	116	121	149
65,000	114	116	124	120	124	132	170	166	151	142	137	117	122	150
66,000	115	117	125	121	125	133	170	168	152	143	138	118	123	151
67,000	116	118	126	122	126	134	170	169	153	144	139	119	124	152
68,000	117	119	127	124	128	135	170	171	155	146	140	120	125	153
69,000	118	120	128	125	129	136	170	172	156	147	141	121	126	154
70,000	119	121	128	126	130	137	170	173	157	148	142	121	127	155
71,000	120	122	129	127	131	138	170	174	158	149	143	122	128	156
72,000	121	123	130	128	132	139	170	175	159	150	144	123	129	157
73,000	122	124	131	129	133	140	170	177	160	151	145	124	130	158
74,000	123	125	132	130	134	140	170	178	161	152	146	125	132	159
75,000	124	126	133	131	135	141	170	179	162	153	148	126	133	160
76,000	125	127	133	132	136	142	170	180	163	154	148	126	134	161
77,000	126	128	134	133	137	143	170	181	164	155	149	127	135	162
78,000	127	129	135	134	138	144	171	182	164	156	150	128	136	164
79,000	128	130	136	135	139	145	173	184	165	157	151	129	136	165
80,000	129	131	137	136	140	146	175	185	167	158	152	130	137	166
81,000	130	132	138	137	141	147	176	186	168	159	153	131	138	167
82,000	130	132	139	138	142	148	178	187	169	160	154	131	139	168
83,000	131	133	140	139	143	149	179	188	170	161	155	132	140	170
84,000	132	134	140	140	143	150	182	190	171	161	156	133	140	171
85,000	133	135	141	141	144	151	183	191	172	162	157	134	140	172
86,000	134	136	142	142	145	151	184	192	173	163	158	135	141	173
87,000	135	137	143	143	146	152	186	193	174	164	158	136	142	175
88,000	136	138	144	144	147	153	188	194	175	165	159	137	143	176
89,000	137	139	145	145	148	154	190	195	176	166	160	138	144	177

V-CHART FOLDER (Not on Checklist)

SLOPE: For each 8 (1.0%) uphill, ADD 3 knots.
For each 8 (1.0%) downhill, SUBTRACT 3 knots.

Supplied by Jeppesen Sanderson

LEFT BLANK INTENTIONALLY

BEFORE START

NOTE: This checklist must be accomplished prior to any aircraft movement to preclude INU malfunction.

Parking Brake - SET/CHECK PRESSURE. Check pressure at 3,000 PSI.

INS - NAV. Check status at 01. Check green navigation light illuminated. Select NAV and check ground speed.

Battery Switch - ON. Check battery annunciator.

Generators - TRIP. This unloads CSDS unit in an effort to prevent shearing shafts during start cycle. Select frequency/voltmeter selector to engine to be started.

Booster Pumps - 4 ON. Observe four lights extinguished; two red and two amber. Check transfer pumps OFF and transfer valves CLOSED. Check no red lights illuminated on long range tanks fuel panel. Check fuel pumps OFF, shutoff valves CLOSED, and press-to-test refuel valve light. Check each tank quantity for proper level. Remainder of check for long range fuel tanks is only applicable if fuel is in long range tanks.

Isolation Valves - OPEN.

MAC Valves - CLOSED. Strive to close MAC valves prior to closing main cabin door.

Mains Pressure - CHECK (25 PSI MINIMUM).

Seat Belt/No Smoking - ON.

Door Warning Lights - TEST/OUT.

Navigation Lights - AS REQUIRED.

Beacons - ON.

Wing Lights/Wheel Well Lights - OFF. Wing and wheel well lights OFF for all start-up, taxi, and inflight operations, except for ice detection. Lights should be ON while aircraft is parked for night servicing.

Engine and Wing Anti-Icing - OFF.

Ignition - HI/LOW. Observe ignition lights.

Start Master - START. Hold momentarily to ensure start circuitry "hold-in". Check green rotation light illuminates and LP rotation on LP tachometer.

Place start lever to START or OPEN. When OAT is 10° or above, select start lever to OPEN; if OAT is below 10°, select start lever to START. At 400° EGT or 50% N2, select start lever to OPEN.

When N2 reaches 13% and LP shaft rotation light illuminates flashing accompanied by N1 tachometer movement, select start lever to START or OPEN.

NOTE: Nominal tachometer range on N2 for initially injecting fuel for start is 13% to 15%.

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ENGINE STARTING (Not on Checklist)

J-CHECK

- Trip each engine generator momentarily.
- Select generator frequency/voltmeter selector to the engine being started (normally No. 2).
- Turn all boost pumps ON, check four lights extinguish.
- Check isolation valves OPEN.
- Position MAC valves to CLOSED. It is desirable to allow time for APU EGT to stabilize prior to starting engines.
- Check mains pressure is at least 25 PSI.
- Engine and airfoil anti-icers OFF.
- Place start master switch to START (or START No. 2 on some aircraft). Move start/relight switch to START momentarily and check that both ignitor lights are illuminated.
- When the green shaft rotation light begins to flash and HP RPM has reached 13%, place HP fuel valve to the OPEN detent.

  NOTE: In the event of a strong tailwind, it is necessary to wait for a steady green shaft rotation light to ensure proper engine rotation.

- Light-off must occur within 5 to 10 seconds after HP fuel valve is moved from SHUT or start must be cancelled.

When engine RPM and TGT stabilizes:

- Select start master switch to OFF.
- Additional callouts during start are as follows:
  - Fuel Flow - NORMAL. (Nominal 500 lbs. to 700 lbs.)
  - Light-off - EGT rise.
  - Hydraulic Pressure - 3,000 PSI, System No. 1 or No. 2.
  - CSDS - Light extinguished.
  - Start Switch - OFF (40% HP RPM). Observe ignitor lights extinguished and LP shaft rotation light extinguished.
- To cancel a start for any reason, select HP fuel valve to SHUT; then, immediately turn start master switch to OFF. Shutting off fuel limits the maximum engine temperature and turning off the start master cuts off air supply to the CSDS, avoiding damage to it.

  NOTE: TGT must not exceed 570° during start. Under normal starting conditions the MAX TGT to be expected is 520°C. If, however, this temperature is exceeded, a log book entry should be made for subsequent Maintenance action. Spurious engine vibration indications may be observed during start and are not cause for an engine start abort.

Supplied by Jeppesen Sanderson

ENGINE STARTING (Not on Checklist)
(cont'd.)

COLD-SOAK START PROCEDURE

Use the following cold-soak start procedure only when OAT is 0°C or below and the pilot considers the engines completely cold-soaked:

- The standard start procedure will prevail until fuel is introduced. At this point, the HP fuel valve should be placed in the START detent.

- Monitor TGT. When the TGT reaches 400°C or engine RPM stabilizes at IDLE (58% to 62% HP RPM), whichever comes first, reposition HP fuel valve to the OPEN detent.

When idle RPM (58% to 62% HP RPM) and TGT are established:

- Select start master switch to OFF at 40% HP RPM. If the ignitor lights and LP shaft rotation lights have not extinguished when HP RPM reaches 40%, select the start master switch to OFF; check light extinguish, then continue the drill.

  NOTE: On some aircraft the HP fuel valve START position may not be marked; it is the detent position between SHUT and OPEN.

  If a hung start is experienced during start with the HP fuel valve lever at OPEN, cancel the start. Wait for the engine to stop rotating, then make a second attempt after approximately 2 to 3 minutes.

- Reset engine generator and check frequency/voltage, then reset generator frequency/volt selector to engine yet to be started.

When idle RPM (58% to 62% HP RPM) stabilizes:

- Check KVA loading on main generator.

- Hydraulic pump ON, check pressures.

- Engine is considered satisfactory if:

  - Vibration indicator level does not exceed 4.5 diversion either at stabilized idle or during acceleration to 84% HP RPM.

  - At 84% HP RPM and during subsequent deceleration, the vibration level is 2 diversion.

  - During rundown from ground idle during shutdown, the vibration level does not exceed 3 diversion.

- Position crossfeed valve to CLOSED. The No. 2 MAC valve may be placed to OPEN position, then the cabin will be receiving air conditioning from the No. 2 engine while the No. 1 engine is being started, if desired.

  NOTE: It is desirable to allow time for APU EGT to stabilize prior to starting engine No. 1.

- Repeat procedure for starting second engine.

AFTER START

INS - NAV. Check status 01. Select NAV and green navigation light illuminated. Check ground speed.

Start Master/Ignition - OFF/LOW.

Electrical Panel - GENERATOR RESET/CHECK. Observe the following:

- DC split light extinguished.

- Battery switch ON. Check annunciator and charging rate.

- DC Voltmeter (Nominal 26 to 28 volts).

- T/R Loads (Nominal 30 to 60 AMPS per side).

- KVA Load (Nominal 10 to 20 volts).

- Frequency/Voltmeter (400 CPS/115 volts) (select ESS).

Fuel Panels - CHECK. Check four pumps ON and crossfeed CLOSED. Refer to Fuel Boost Pumps, BEFORE START checklist in this chapter.

MAC Valves/Temperature Controls - APU/AUTO.

Air Crossfeed - OPEN/CHECK M.I.

Pitot/Windshield Heat - ON/LOW. Check 5 ON. Check loadmeters. Observe pitot heat monitor lights extinguished, stall vane lights extinguished and windshield LOW/ON lights extinguished.

Master Warning - ARMED. Check lights extinguished.

Hydraulic Panel - ENG. PUMPS ON/AC PUMPS OFF/CHECK PRESSURE/QUANTITY. Select engine pumps ON and AC pumps OFF. Check pressure on System No. 1 and No. 2 at 3,000 PSI. Check 2 in-line (FRET) and all lights extinguished. Confirm FRET handles DOWN.

Pressurization - SET FOR T.O. Check Data Plate forward of throttle quadrant as follows:

- Barometric Correction Knob - Set 29.92.

- Cabin Altitude Knob - Set according to Data Plate. In no case will cabin be set less than 500 feet above departing airport elevation.

- Rate of Climb Knob - Set to 12 o'clock position (500 FPM UP).

- In no case will the aircraft takeoff or land pressurized.

Safety Valve - CLOSED.

Anti-Skid - OFF. Check four blanks. During multi-stops, it is possible to build up unwanted brake temperature. Check brake temperature prior to leaving the gate so that the Captain will be aware of any impending delay if brakes do not cool below 200° before takeoff.

LEFT BLANK INTENTIONALLY

PUSH-OUT/TAXI-AWAY (Not on Checklist)

COCKPIT-TO-GROUND COMMUNICATION

Communication between Captain and Signalman is based on the following procedure:

- All communication between Captain and Signalman will be by interphone, except when Signalman gives departure signal. All of the Captain's audio selector panel switches should be OFF during engine start and/or push-out. If interphone is inoperative, use hand signals.

- After receiving, "Start Engines" signal from Signalman, Captain will acknowledge, "Ready to Start Engines - Parking Brake - Parked."

- After engines are started, Captain will advise Signalman, "2 Normal Starts".

WHEN START FOLLOWED BY TAXI-AWAY

- After receiving "Normal Starts" call, Signalman will state, "Disconnecting Interphone". Captain will acknowledge. Signalman will proceed to specified departure salute area and wait.

- When s/he is ready to taxi, Captain will flash the runway turnoff lights one time. Signalman will visually clear area and give departure salute, indicating to the Captain that s/he is clear to taxi.

- If necessary to recall Signalman to interphone, Captain will flash the runway turnoff lights three times.

WHEN START FOLLOWED BY PUSH-OUT

- Signalman will advise Captain, "Ready to Tow - Parking Brake - Released" indicating tractor brakes are on, chocks are removed, loading bridge retracted and/or plane mate(s) clear, and ramp area is clear. Captain will verify that door warning lights are extinguished and acknowledge with "Ready to Tow - Parking Brake - Released".

- At end of push-out (tow), Signalman will request "Parking Brake - Parked". Captain will acknowledge, "Parking Brake - Parked", indicating airplane Parking Brake is set and tow bar may be disconnected. Signalman will disconnect tow bar then advise, "Clearing the Area - Disconnecting Interphone". Captain will acknowledge so Signalman will proceed to specified departure salute area and wait.

- When the Captain is ready to Taxi, s/he will flash the runway turnoff lights one time. Signalman will visually clear area and give departure salute, indicating to the Captain that s/he is clear to taxi.

- If necessary to recall Signalman to interphone, Captain will flash runway turnoff lights three times.

LEFT BLANK INTENTIONALLY

TAXI CHECK

Brakes & Steering - CHECKED. Verify brakes by observing foot brake pressure. Keep passenger comfort in mind. Verify steering as well as the brakes by REACTION.

Speedbrakes - FWD/COLLAR UP.

Flaps - SET T.O. Select flaps to desired setting; 3°/8°/18°. Observe flap indicator goes to 3°/8°/18°. Call flaps selected 3°/8°/18°.

Trim - (3) SET T.O. Callout actual units set on tailplane, rudder and aileron.

Reversers - CHECKED/LIGHTS OUT. On intermediate stops, reversers CHECKED/FORWARD/LIGHTS OUT. On originating flights, exercise reversers on first flight of the day. After F/O has called out AMBERS/AMBIENT, reversers CHECKED/FORWARD/LIGHTS OUT.

Flight Instruments/Flight Directors - CHECKED/SET.

FLIGHT INSTRUMENTS

The F/O will read aloud using the following flow pattern. The Captain will respond to each callout by saying "CHECKED", with the exception of the altimeters to which both pilots will call "BAROMETRIC PRESSURE _____" "FIELD ELEVATION _____ FEET". Confirm elevation.

- Airspeed - zero.

- HDI - Pitch and bank zero. F/D in HDG mode. V-bars set for takeoff. No gyro/computer flags.

- Radio Altimeter - Reset.

- Altimeters - _____ inches/_____ feet.

- RMDI - Heading/course set/HDG bug set on runway heading/no flags.

- IVSI - zero.

- Clocks - Set.

Observe HDI, CDI and cross-switching are normal.

Observe backcourse, RMI mode switches are normal.

FLIGHT DIRECTOR

Flight Director INS Switch - LIGHT OUT/RADIO. Verify CDI needles are offset, ADI moving runway is offset, and V-bars are offset.

NOTE: Takeoffs or landings are not permitted when INU information is displayed on the flight director.

(cont'd.)

TAXI CHECK (cont'd.)

Flight Instruments/Flight Directors - CHECKED/SET. (cont'd.)

FLIGHT DIRECTOR (cont'd.)

Takeoff Data - SET/CROSS-CHECK. Verify P7, V1, Vr, V2, VFS posted (for flap setting). Set V1 and V2. Call out actual numbers and respond "SET".

Call out runway length available and runway length required.

Airspeed Command Bugs - CHECK/SET. The inside bug is to be placed to V1 and the outside bug to V2 on the Captain's and F/O's airspeed indicators. Both pilots memorize Vr.

Engine Anti-Ice - CHECK/AS REQUIRED. On the first flight of the day, check by placing switches ON. Read pressure; it should be equal. Place switches to OFF. This check should also be accomplished during descent on the first flight of the day. Compare P7 for equal drop and increase during inflight check.

APU - AS REQUIRED. Read EGT. Fire warning AUTO.

Side Windows - LOCKED. Check side windows locked and button is up.

RATED POWER - P7 (AIR CONDITIONING ON)

BAC 1-11/401
P7 MINIMUM CHART/511 RATING

Engine anti-icing OFF/ON — Air conditioning ON — Wing anti-ice OFF

ALT. FEET	In Hg.	PRESS. ALT. mb	Outside Air Temperature °C																				
			−40	−36	−32	−28	−24	−20	−16	−12	−8	−4	0	+4	+8	+12	+16	+20	+24	+28	+32	+36	+40	+44	+48
ALT. FEET	IN. Hg.	PRESS. ALT. mb	Outside Air Temperature °F																				
			−40	−33	−26	−18	−11	− 4	+ 3	+10	+18	+25	+32	+39	+46	+54	+61	+68	+75	+82	+90	+97	+104	+111	+118
−2300	32.48	1100	75.4	75.4	75.4	75.4	75.4	75.4	75.4	75.4	75.4	75.4	75.4	75.4	75.4	75.4	75.4	75.4	75.4	75.4	74.9	73.3	71.1	70.0	68.4
−2050	32.19	1090	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	72.6	71.0	69.4	67.8
−1750	31.89	1080	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.0	73.5	71.9	70.3	68.7	67.1
−1500	31.59	1070	74.9	74.9	74.9	74.9	74.9	74.9	74.9	74.9	74.9	74.9	74.9	74.9	74.9	74.9	74.9	74.9	74.9	74.3	72.8	71.2	69.6	68.1	66.5
−1250	31.30	1060	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	74.7	73.6	72.1	70.5	69.0	67.4	65.8
−1000	31.00	1050	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.2	72.9	71.4	69.9	68.3	66.8	65.2
− 700	30.71	1040	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	73.5	72.1	70.7	69.2	67.6	66.1	64.5
− 450	30.41	1030	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	72.8	71.4	70.0	68.5	67.0	65.4	63.9
− 200	30.12	1020	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.1	72.0	70.7	69.3	67.8	66.3	64.8	63.3
+ 100	29.82	1010	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.1	72.4	71.3	70.0	68.6	67.1	65.6	64.1	62.6
+ 350	29.53	1000	73.0	73.0	73.0	73.0	73.0	73.0	73.0	73.0	73.0	73.0	73.0	73.0	73.0	73.0	72.4	71.6	70.6	69.3	67.9	66.4	65.0	63.5	62.0
+ 650	29.23	990	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.8	72.3	71.8	70.9	69.9	68.6	67.2	65.8	64.3	62.9	61.4
+ 950	28.94	980	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.1	71.6	71.1	70.2	69.2	67.9	66.5	65.1	63.6	62.2	60.7
+1200	28.64	970	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.0	71.4	70.9	70.4	69.5	68.4	67.2	65.8	64.4	63.0	61.5	–
+1500	28.35	960	72.3	72.3	72.3	72.3	72.3	72.3	72.3	72.3	72.3	72.3	71.9	71.3	70.8	70.2	69.6	68.7	67.7	66.5	65.1	63.7	62.3	60.9	–
+1800	28.05	950	72.2	72.2	72.2	72.2	72.2	72.2	72.2	72.2	72.1	71.6	71.1	70.6	70.1	69.5	68.9	68.0	67.0	65.8	64.4	63.0	61.6	60.2	–
+2050	27.76	940	71.9	71.9	71.9	71.9	71.9	71.9	71.9	71.9	71.4	70.9	70.4	69.9	69.4	68.8	68.1	67.3	66.3	65.1	63.7	62.4	61.0	59.6	–
+2350	27.46	930	71.7	71.7	71.7	71.7	71.7	71.7	71.6	71.1	70.7	70.2	69.7	69.2	68.7	68.1	67.4	66.5	65.5	64.3	63.0	61.7	60.3	58.9	–
+2650	27.17	920	71.5	71.5	71.5	71.5	71.5	71.3	70.9	70.4	70.0	69.5	69.0	68.5	68.0	67.4	66.7	65.8	64.8	63.6	62.3	61.0	59.6	58.3	–
+2950	26.89	910	71.3	71.3	71.3	71.3	71.0	70.6	70.1	69.7	69.2	68.8	68.3	67.8	67.3	66.8	65.9	65.1	64.1	62.9	61.6	60.3	59.0	57.6	–
+3250	26.58	900	71.1	71.1	71.1	70.7	70.3	69.8	69.4	68.9	68.5	68.0	67.6	67.1	66.6	66.1	65.2	64.3	63.4	62.2	60.9	59.6	58.3	–	–
+3550	26.28	890	70.8	70.8	70.4	70.0	69.5	69.1	68.7	68.2	67.8	67.3	66.9	66.4	65.9	65.3	64.5	63.6	62.7	61.5	60.2	59.0	57.6	–	–
+3850	26.00	880	70.6	70.1	69.7	69.2	68.8	68.3	67.9	67.5	67.0	66.6	66.1	65.7	65.2	64.5	63.7	62.9	62.0	60.8	59.5	58.3	57.0	–	–
+4150	25.69	870	69.8	69.3	68.9	68.4	68.0	67.6	67.2	66.7	66.3	65.9	65.4	65.0	64.5	63.8	63.0	62.1	61.2	60.1	58.9	57.6	56.3	–	–
+4450	25.39	860	69.0	68.6	68.1	67.7	67.3	66.8	66.4	66.0	65.6	65.2	64.7	64.2	63.8	63.1	62.2	61.4	60.5	59.4	58.2	56.9	55.6	–	–
+4800	25.10	850	68.3	67.8	67.4	66.9	66.5	66.1	65.7	65.3	64.8	64.4	64.0	63.5	63.1	62.3	61.5	60.7	59.8	58.7	57.4	56.2	55.0	–	–
+5100	24.80	840	67.5	67.0	66.6	66.2	65.8	65.3	64.9	64.5	64.1	63.7	63.3	62.8	62.3	61.5	60.8	60.0	59.1	58.0	56.8	55.5	–	–	–
+5400	24.51	830	66.7	66.3	65.9	65.4	65.0	64.6	64.2	63.8	63.4	63.0	62.5	62.1	61.6	60.8	60.0	59.2	58.3	57.2	56.1	54.9	–	–	–
+5750	24.21	820	65.9	65.5	65.1	64.7	64.2	63.8	63.4	63.0	62.6	62.2	61.8	61.4	60.8	60.1	59.3	58.5	57.6	56.5	55.4	54.2	–	–	–
+6050	23.92	810	65.2	64.8	64.3	63.9	63.5	63.1	62.7	62.3	61.9	61.5	61.1	60.7	60.1	59.3	58.5	57.8	56.9	55.8	54.6	53.5	–	–	–
+6400	23.62	800	64.4	64.0	63.5	63.1	62.7	62.3	62.0	61.6	61.2	60.8	60.4	59.9	59.3	58.5	57.8	57.0	56.2	55.1	54.0	52.8	–	–	–
+6750	23.33	790	63.6	63.2	62.8	62.4	62.0	61.6	61.2	60.8	60.4	60.1	59.6	59.2	58.6	57.8	57.1	56.3	55.5	54.4	53.3	52.1	–	–	–
+7050	23.03	780	62.8	62.4	62.0	61.6	61.2	60.8	60.5	60.1	59.7	59.3	58.9	58.5	57.8	57.1	56.3	55.6	54.7	53.7	52.6	–	–	–	–
+7400	22.74	770	62.1	61.7	61.3	60.9	60.5	60.1	59.7	59.3	59.0	58.6	58.2	57.8	57.1	56.3	55.6	54.9	54.0	53.0	51.9	–	–	–	–
+7750	22.44	760	61.3	60.9	60.5	60.1	59.7	59.3	59.0	58.6	58.2	57.8	57.5	57.0	56.3	55.6	54.9	54.1	53.3	52.3	51.2	–	–	–	–
+8100	22.15	750	60.5	60.1	59.7	59.3	59.0	58.6	58.2	57.9	57.5	57.1	56.7	56.2	55.5	54.8	54.1	53.4	52.6	51.6	50.5	–	–	–	–
+8450	21.85	740	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
+8800	21.56	730	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
+9150	21.26	720	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
+9500	20.97	710	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
+9900	20.67	700	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

RATED POWER - P7 (AIR CONDITIONING OFF)

BAC 1-11/401
P7 MINIMUM CHART/511 RATING

Engine anti-icing OFF/ON — Air conditioning OFF — Wing anti-ice OFF

ALT. FEET	In Hg.	PRESS. ALT. mb	Outside Air Temperature °C																				
			-40	-36	-32	-28	-24	-20	-16	-12	-8	-4	0	+4	+8	+12	+16	+20	+24	+28	+32	+36	+40	+44	+48
ALT. FEET	IN. Hg.	PRESS. ALT. mb	Outside Air Temperature °F																				
			-40	-33	-26	-18	-11	-4	+3	+10	+18	+25	+32	+39	+46	+54	+61	+68	+75	+82	+90	+97	+104	+111	+118
-2300	32.48	1100	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	75.5	74.7	73.1	71.5	69.8
-2050	32.19	1090	75.3	75.3	75.3	75.3	75.3	75.3	75.3	75.3	75.3	75.3	75.3	75.3	75.3	75.3	75.3	75.3	75.3	75.3	75.3	74.0	72.4	70.8	69.2
-1750	31.89	1080	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	75.1	74.9	73.3	71.8	70.2	68.5
-1500	31.59	1070	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	74.2	72.7	71.1	69.5	67.9
-1250	31.30	1060	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	73.5	72.0	70.4	68.9	67.2
-1000	31.00	1050	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.6	74.3	72.8	71.3	69.8	68.2	66.6
- 700	30.71	1040	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	73.6	72.1	70.6	69.1	67.5	66.0
- 450	30.41	1030	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.0	72.8	71.4	69.9	68.4	66.9	66.3
- 200	30.12	1020	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.3	72.1	70.7	69.2	67.8	66.2	64.7
+ 100	29.82	1010	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	72.6	71.4	70.0	68.5	67.1	65.6	64.0
+ 350	29.53	1000	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	72.9	71.9	70.7	69.3	67.9	66.4	64.9	63.4
+ 650	29.23	990	72.9	72.9	72.9	72.9	72.9	72.9	72.9	72.9	72.9	72.9	72.9	72.9	72.9	72.9	72.7	72.1	71.1	70.0	68.6	67.2	65.7	64.3	62.8
+ 950	28.94	980	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.6	72.0	71.4	70.4	69.3	67.9	66.5	65.1	63.6	62.1
+1200	28.64	970	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.5	72.4	71.9	71.4	70.7	69.7	68.6	67.2	65.8	64.4	62.9	–
+1500	28.35	960	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.3	71.7	71.2	70.7	69.9	69.0	67.9	66.5	65.1	63.7	62.3	–
+1800	28.05	950	72.2	72.2	72.2	72.2	72.2	72.2	72.2	72.2	72.2	72.2	72.1	71.6	71.0	70.5	70.0	69.2	68.2	67.1	65.8	64.4	63.1	61.6	–
+2050	27.76	940	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	72.0	71.8	71.3	70.9	70.3	69.8	69.3	68.5	67.5	66.4	65.1	63.8	62.4	61.0	–
+2350	27.46	930	71.8	71.8	71.8	71.8	71.8	71.8	71.8	71.8	71.6	71.1	70.6	70.1	69.6	69.1	68.6	67.7	66.8	65.7	64.4	63.1	61.7	60.3	–
+2650	27.17	920	71.5	71.5	71.5	71.5	71.5	71.5	71.5	71.3	70.9	70.4	69.9	69.4	68.9	68.4	67.9	67.0	66.1	65.0	63.7	62.4	61.0	59.7	–
+2950	26.89	910	71.3	71.3	71.3	71.3	71.3	71.3	71.0	70.5	70.1	69.7	69.2	68.7	68.2	67.7	67.1	66.3	65.3	64.3	63.0	61.7	60.4	59.0	–
+3250	26.58	900	71.0	71.0	71.0	71.0	71.0	70.7	70.2	69.8	69.4	69.0	68.5	68.0	67.5	67.0	66.4	65.5	64.6	63.6	62.3	61.0	59.7	–	–
+3550	26.28	890	70.8	70.8	70.8	70.7	70.3	69.9	69.5	69.1	68.7	68.2	67.8	67.3	66.8	66.3	65.8	64.8	63.9	62.9	61.6	60.3	59.0	–	–
+3850	26.00	880	70.5	70.5	70.4	70.0	69.6	69.2	68.8	68.3	67.9	67.5	67.1	66.6	66.1	65.6	64.9	64.1	63.2	62.2	60.9	59.6	58.4	–	–
+4150	25.69	870	70.2	70.1	69.6	69.2	68.8	68.4	68.0	67.6	67.2	66.8	66.3	65.9	65.4	64.9	64.2	63.3	62.5	61.4	60.2	59.0	57.7	–	–
+4450	25.39	860	69.7	69.3	68.9	68.5	68.1	67.7	67.3	66.9	66.4	66.1	65.6	65.2	64.7	64.2	63.4	62.6	61.7	60.7	59.5	58.3	57.0	–	–
+4800	25.10	850	69.0	68.5	68.1	67.7	67.3	66.9	66.5	66.1	65.7	65.3	64.9	64.4	64.0	63.5	62.7	61.9	61.0	60.0	58.8	57.6	56.3	–	–
+5100	24.80	840	68.2	67.8	67.3	66.9	66.5	66.1	65.8	65.4	65.0	64.6	64.2	63.7	63.3	62.7	61.9	61.1	60.3	59.3	58.1	56.9	–	–	–
+5400	24.51	830	67.4	67.0	66.6	66.1	65.8	65.4	65.0	64.7	64.2	63.9	63.4	63.0	62.6	62.0	61.2	60.4	59.6	58.6	57.4	56.2	–	–	–
+5750	24.21	820	66.6	66.2	65.8	65.4	65.0	64.7	64.3	63.9	63.5	63.1	62.7	62.3	61.9	61.2	60.4	59.7	58.9	57.9	56.7	55.5	–	–	–
+6050	23.92	810	65.9	65.5	65.1	64.7	64.3	63.9	63.5	63.2	62.8	62.4	62.0	61.6	61.2	60.5	59.7	59.0	58.1	57.2	56.0	54.9	–	–	–
+6400	23.62	800	65.1	64.7	64.3	63.9	63.5	63.1	62.7	62.4	62.0	61.6	61.3	60.9	60.4	59.7	59.0	58.2	57.4	56.5	55.3	54.2	–	–	–
+6750	28.33	790	64.3	63.9	63.5	63.1	62.8	62.4	62.0	61.7	61.3	60.9	60.5	60.1	59.7	59.0	58.2	57.5	56.7	55.7	54.6	53.5	–	–	–
+7050	23.03	780	63.5	63.1	62.8	62.4	62.0	61.6	61.3	60.9	60.5	60.2	59.8	59.4	59.0	58.2	57.5	56.8	56.0	55.9	53.0	–	–	–	–
+7400	22.74	770	62.8	62.4	62.0	61.6	61.2	60.9	60.5	60.2	59.8	59.4	59.1	58.7	58.2	57.5	56.7	56.0	55.2	54.3	53.2	–	–	–	–
+7750	22.44	760	62.0	61.6	61.2	60.9	60.5	60.1	59.8	59.4	59.1	58.7	58.3	58.0	57.4	56.7	56.0	55.3	54.5	53.6	52.5	–	–	–	–
+8100	22.15	750	61.2	60.8	60.4	60.0	59.7	59.4	59.0	58.7	58.3	58.0	57.6	57.2	56.7	56.0	55.3	54.5	53.8	52.9	51.8	–	–	–	–
+8450	21.85	740	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
+8800	21.56	730	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
+9150	21.26	720	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
+9500	20.97	710	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
+9900	20.67	700	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

BEFORE TAKEOFF

Shoulder Harness - FASTENED.

Controls - FREE. Check free and full travel of all controls. Check that rudder, elevators, and spoilers are receiving hydraulic power and the rudder feel light is extinguished. Monitor FRET and spoiler fail lights during control actuation. Generally, the pilot flying checks rudder travel while the non-flying pilot checks ailerons/spoilers and elevators.

Standby Horizon - CHECKED. Check for erection, no flag.

Line-up items may be accomplished while taxiing into position or in position if the Captain anticipates a delay.

Anti-skid/Brake Temperature - ON/CHECK. Check for 4 "blanks". Check brake temperature below 200°C for takeoff, 400°C for gear retraction.

No. 1 Auxiliary Hydraulic Pump - ON. Check electrical load. Observe No. 2 AC bus for current draw or excessive load.

Transponder - ON.

Landing Lights - ON. For daytime operations, use taxi and turnoff lights. For nighttime operations, use landing, nose, and turnoff lights for operations in immediate vicinity of the airport and taxi and turnoff lights for other operations.

Turn landing lights ON just prior to initiating takeoff roll to indicate airplane is starting takeoff roll.

Anti-Collision Lights - ON. White is the normal position.

Ignitors - RELIGHT.

The following information is not found on checklist:

- Engine Anti-icing must be ON for taxiing and takeoff when OAT is below +50°F (+10°C) and visible moisture (fog, rain, sleet or wet snow) is present.

  When holding on the ground, if engine anti-icing is ON, engines should be accelerated to approximately 90% N2 for 3 or 4 seconds at about 8-minute intervals to ensure adequate rotor/stator anti-icing at low engine speed.

- Wing and Tail Anti-icing shall not be ON during the actual takeoff. When OAT is below +23°F (-5°C) and fog, rain, wet snow or sleet are present, turn airframe anti-icing ON following takeoff after all obstacles in takeoff flight path have been cleared, but prior to reaching 1,500 feet AGL.

(cont'd.)

BEFORE TAKEOFF (cont'd.)

The following information is not found on a checklist: (cont'd.)

- Wing and Tail Anti-icing (cont'd.)

  Before turning on airframe anti-icing, close the air delivery valve and air crossfeed valve, and select both master valves to OPEN to insure against possible APU overtemperature or trip.

  If there is a possibility of airfoil icing during or shortly after takeoff, wings may be preheated before takeoff, if desired, by holding wing anti-ice switches to TEST. Preheating of tail before takeoff is not normally considered necessary.

- Static Check should be accomplished when maintenance has been performed on the static system. Perform check by closing left master valve. As cabin rate of climb starts UP, Captain and F/O shall check their vertical speed indicators to assure there is no movement. After check, reposition master valve to APU (or to OPEN, if APU is shut down).

- Takeoff with APU Shutdown (Unpressurized):

  - Select cabin altitude to at least 2000 feet AGL.

  - Just before takeoff, ensure that both master valve selectors are positioned to APU, air crossfeed valve to OPEN, air delivery valve is closed, ram air is open and safety valve is open. Both master valve selectors must remain in the APU position until reaching at least 400 feet AGL, then place right selector to OPEN. After mains pressure stabilizes, open left master valve. When mains pressure stabilizes, close safety valve, ram air valve, and air crossfeed valve. In the event of a delay in pressurizing the airplane, check that selected cabin altitude is above airplane altitude before closing ram air and safety valves.

    If engine failure occurs before reaching 400 feet, leave the master valve for operating engine positioned to APU until reaching at least 1,500 feet AGL. If failure occurs between 400 feet and 1,500 feet, immediately return operating engines master valve to APU.

  - Select desired cabin altitude. Remember to "snub" cabin pressure rate control before reselecting altitude.

- Windshield Heat must be set from LOW to HIGH if temperature on the ground is below -15°C; in FLIGHT, the temperature is below -5°C or the underheat lights are ON. If windows are cold-soaked, warm gradually by 10-second cycling between OFF and LOW for about one minute.

TAKEOFFS (Not on Checklist)

GENERAL

When takeoff clearance is received and the Before Takeoff checklist is completed, taxi on the runway, aligning the nose wheel with the centerline (with centerline lights installed on the runway, it may be desirable to track the nose wheel slightly off center to avoid surface roughness during the takeoff roll). When in or turning into takeoff position, the pilot flying should smoothly advance the throttles to chart rated takeoff thrust. The pilot not flying should back up the throttles, monitor the power, and make final adjustments. The yoke should be guarded by the pilot not flying after the pilot flying has relinquished it.

NOTE: During crosswind conditions, maximum aileron input should be limited to 15° of yoke travel to prevent spoiler deployment.

Monitor engine indications during takeoff run (i.e., P7, EGT, RPM, oil pressure and temperature, etc.). Check overhead panel (LP RPM, engine anti-ice pressure, lights, etc.). Adjust by 60 knots as necessary to keep indication within limits. If maximum power takeoff is being made, P7 should not be 4" over minimum P7 (P3 limiter not functioning).

NOTE: For "static" takeoffs, advance power to 44" prior to brake release.

REJECTED TAKEOFF

The decision to reject any takeoff will be made by the Captain; therefore, when the First Officer is executing the takeoff, s/he should remove his/her hand from the throttles after setting rated takeoff thrust. The Captain will then place his/her hand on the throttles until V1, so that s/he may rapidly retard the throttles should s/he decide to initiate a reject.

To reduce fuel consumption and improve engine reliability, power should be advanced only to the rated value for takeoff, not full throttle. (Advance to maximum power with an engine failure.)

Rejecting a takoff at high speeds is potentially dangerous. It would be considered necessary with an engine failure and with other possibly serious situations, such as a takeoff warning horn continuously sounding, with a reason for it not immediately apparent with a quick pedestal check. A reject at V1 that is perfectly executed may require every foot of the remaining runway. Anything less than maximum effort throughout the entire stopping attempt could result in running off the end of the runway. Barring an actual engine failure or similar serious situation prior to V1, the aircraft has a greater capability for successfully continuing the takeoff than to stop.

The decision to reject a takeoff is the sole responsibility of the Captain. If the takeoff is rejected, regardless of which pilot is making the takeoff, the Captain initiates the reject using the following procedures: Apply full brakes while closing the throttles. Extend spoilers and apply reverse thrust. The control tower should be advised of intentions and the problem. It is also desirable to inform the passengers via the P.A. of the situation to relieve apprehension.

Supplied by Jeppesen Sanderson

**TAKEOFFS (Not on Checklist)
(cont'd.)**

USE OF LESS THAN MAXIMUM TAKEOFF POWER

The following considerations apply before a takeoff can be made using such power setting less than maximum:

- It is at the Captain's discretion to use a takeoff power setting less than the maximum power permitted for the existing conditions.

- Conditions and requirements outlined in the aircraft's operating manual or AFM shall be adhered to when planning the takeoff power setting, whether "RATED" or maximum power.

- When less than maximum power is permitted for takeoff and is planned by the flight deck crew, the following should be considered as a possible need for maximum power:

  - The airport pressure altitude.

  - The use of engine anti-ice takeoff.

  - The runway slope.

  - The condition of the runway surface and the possible presence of contamination on the runway (snow, standing water, slush, etc.).

  - The terrain in the departure area.

TAKEOFF ON WET OR SLIPPERY RUNWAYS

At approximately 70 knots during takeoff in standing water, slush or wet snow, hydroplaning starts. Water will be thrown up by the main wheels and nose wheels. Some of the water from the nose wheel will pass over the wings and some of this will enter engine intakes. Water from the main wheels will not go near the engine intakes but a large proportion will strike the flaps. The engines can tolerate quite large quantities of water without damage or malfunction, but use of the igniters gives added protection against possible flameout.

Strict observance of Company limitations on operation in various slush, standing water, and snow depths gives protection against damage to the aircraft structure and serious deterioration of aircraft performance.

After runway line-up, release nosewheel steering and take control of yoke. The pilot not flying should call 80 knots, 100 knots, V1, Vr, V2, V2 + 10, positive rate. At V1, the pilot not flying should guard the throttle until initial flap retraction.

At V1/Vr, a smooth rotation should be made to a pitch up angle of approximately 12° which will result in attaining V2 speed at 35 feet. Maintain that attitude (not to exceed 15°) and the airspeed will quickly accelerate beyond V2, which is normal. As soon as definitely airborne with a positive rate of climb, the pilot flying commands gear retraction.

TAKEOFFS (Not on Checklist)
(cont'd.)

NOISE ABATEMENT TAKEOFF

Runway or noise abatement heading should be maintained initially. climb should be made at V2 + 10 knots or higher as necessary to limit deck angle to 15°. At 1,000 feet above field level, raise flaps to 8° (or 0°, if V2 + 20 knots), reduce to climb power, 94.0%* HP RPM and/or 480°C* TGT. Pitch attitude can be reduced by 5-6° (or not more than one-half of the pitch attitude required to hold V2 + 10), if necessary to accelerate to 0° flap speed. Continue climbing during flap retraction and power reduction, accelerate to zero flap maneuver speed for climb to 3,000 feet above field level. Accelerate to 250 knots maintaining an approximate 1,000 FPM climb rate during acceleration. The pilot flying should command the pilot not flying to complete the AFTER TAKEOFF checklist.

*If gross takeoff weight is over 78,000 lbs., use 94.5% HP RPM/490°C EGT.

NOTE: The noise abatement climb profile above is used for all takeoffs except at New York area and Washington National airports. See Noise Abatement Takeoff profiles in this section for procedures at those airports.

Takeoff procedures with an engine failure after V1, wherein the takeoff is continued, are detailed in Chapter 18 - TRAINING of this manual.

MAXIMUM DEPARTURE SPEEDS

- 200 knots in airport traffic area (except in TCA).
- 200 knots under the floor and within the lateral limits of a TCA.
- 250 knots below 10,000 feet (Domestic). For international flights, use value depicted on airway chart, terminal arrival chart, approach chart, or air regulations for the particular country.
- 280 knots above 10,000 feet to FL270. M.70 to above FL270.
- 300 knots above 10,000 feet for ATC convenience.
- 250-270 knots turbulence airspeed.

Supplied by Jeppesen Sanderson

STANDARD NOISE ABATEMENT TAKEOFF PROFILE

This is the normal takeoff profile to be used on all takeoffs except New York area airports and Washington National. (Use this standard procedure profile for New York area airports **except** make first flap and power reduction at 1,500 feet AFL instead of 1,000 feet. A separate profile procedure is provided for Washington National.)

SAFETY IS OF PRIMARY CONCERN when following this procedure. Pilot judgment will remain as the overriding factor in determining whether or not the noise abatement procedure will be strictly adhered to, based upon flight conditions encountered. The takeoff procedure is applicable to straight out departures and relatively stable air conditions; some adjustment in speed schedules are permitted, if necessary, for turns exceeding 15° banks and with windshear/turbulence reported or forecast.

I. First Segment - Takeoff to 1,000 feet.

1. Takeoff power.
2. V2 + 10 (+)*
3. Takeoff flaps.

*(Limited by 15° - 16° pitch attitude).

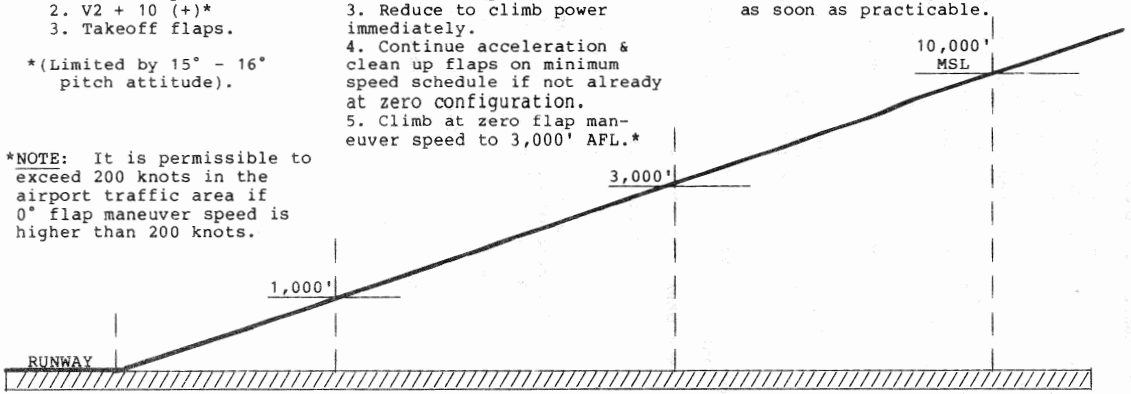
II. Second Segment - 1,000 feet to 3,000 feet AFL

1. Reduce pitch attitude by 5-6° (not more than 1/2 of pitch attitude required for V2 + 10 climb).
2. Continue climb. Start flap retraction at appropriate minimum speed.
3. Reduce to climb power immediately.
4. Continue acceleration & clean up flaps on minimum speed schedule if not already at zero configuration.
5. Climb at zero flap maneuver speed to 3,000' AFL.*

III. Third Segment - After 3,000 feet AFL

Accelerate expeditiously to 250 knots, maintaining an approximate rate of climb of 1,000 FPM during acceleration. Climb at 250 knots to 10,000 ft. MSL. If unable to achieve positive rate of climb while accelerating, advise ATC as soon as practicable.

*NOTE: It is permissible to exceed 200 knots in the airport traffic area if 0° flap maneuver speed is higher than 200 knots.



TAKEOFFS (Not on Checklist) (cont'd.)

Supplied by Jeppesen Sanderson

NOISE ABATEMENT TAKEOFF PROFILE - WASHINGTON NATIONAL AIRPORT

SAFETY IS OF PRIMARY CONCERN when following this procedure. Pilot judgment will remain as the overriding factor in determining whether or not the noise abatement procedure will be strictly adhered to, based upon flight conditions encountered. (See the following page for additional information).

I. First Segment - Takeoff to 1,500 Feet.

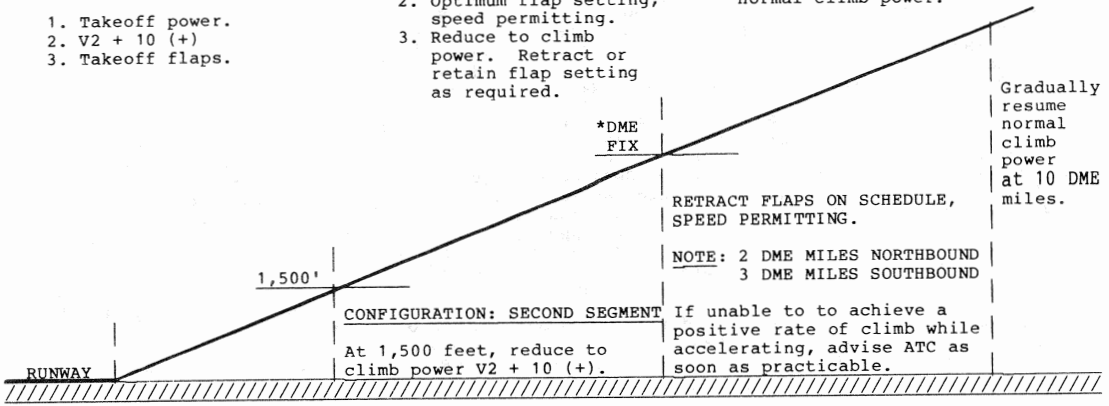
1. Takeoff power.
2. V2 + 10 (+)
3. Takeoff flaps.

II. Second Segment - At 1,500 Feet to DME Fix*

1. V2 + 10 (+)
2. Optimum flap setting, speed permitting.
3. Reduce to climb power. Retract or retain flap setting as required.

III. Third Segment - Climb

At 2 DME miles northbound and 3 DME miles southbound, reduce to 91% HP RPM. Upon reaching the DCA 10 DME ARC, gradually increase to normal climb power.


*DME FIX
Gradually resume normal climb power at 10 DME miles.
RETRACT FLAPS ON SCHEDULE, SPEED PERMITTING.
NOTE: 2 DME MILES NORTHBOUND
3 DME MILES SOUTHBOUND
1,500'
CONFIGURATION: SECOND SEGMENT
At 1,500 feet, reduce to climb power V2 + 10 (+).
If unable to to achieve a positive rate of climb while accelerating, advise ATC as soon as practicable.
RUNWAY

Northwest Departures: Via Potomac River to abeam Georgetown Reservoir, thence continue over the river of via the DCA 326° radial until past the 10 DME ARC.

Northeast Departures: Via Anacosta River to the DCA 5 DME fix. Continue at reduced power pas a DCA 10 DME ARC.

South Departures: Via DCA 183° to the 5 DME fix. Continue at reduced power past a 10 DME ARC.

TAKEOFFS (Not on Checklist) (cont'd.)

Supplied by Jeppesen Sanderson

NOISE ABATEMENT TAKEOFF PROFILE - WASHINGTON NATIONAL AIRPORT (cont'd.)

FIRST SEGMENT	SECOND SEGMENT	THIRD SEGMENT
Referral to use of takeoff power and flap means that takeoff power and flap setting required for the load and the runway being used. It was recognized that some aircraft may have difficulty in maintaining V2 + 10 without too steep a body angle. The speed recommended should be maintained as far as possible but without exceeding the aircraft body angle limitation, 15°. To cater to this difference, the symbol "(+)" has been used in the procedure to allow speed acceleration beyond V2 + 10.	It was recognized that it may be necessary to increase speed to achieve the optimum flap setting required in entering the Second Segment at 1,500 feet. Again the symbol "(+)" is used for the airspeed at 1,500 feet to DME fix (2 DME miles northbound, 3 DME miles southbound) to allow speed acceleration when required to enable a lesser flap setting. It is not to be interpreted to permit unlimited airspeed. Strict speed discipline is required to make the procedure beneficial and in order that departure separation established by ATC not be jeopardized. Reduction of power at 1,500 feet would achieve the best noise reduction for the greatest number of people in the area under or near the takeoff path. The single "climb power" desired would approximate a 1,000 feet per minute climb.	The third segment, as used in DCA Noise Abatement procedures, is the area between the DME fix and the DCA 10 DME ARC. After reaching the DME fix and starting your Third Segment Climb, reduce EPR to 1.55. At this time, retract flaps on schedule, speed permitting. Continue to use the reduced EPR. Upon reaching the DCA 10 DME ARC, gradually increase to normal climb power. This is the critical noise area. So after reaching 10 DME miles, DO NOT INCREASE POWER ABRUPTLY. This is very noticeable on the ground. Be sure to increase it gradually.

When noise abatement procedures are completed and congested areas cleared, the pilot flying shall call for the After Takeoff checklist. The non-flying pilot may accomplish the checklist silently and should then announce it completed.

TAKEOFFS (Not on Checklist) (cont'd.)

Supplied by Jeppesen Sanderson

AFTER TAKEOFF

Gear/Flaps - UP. When IVSI indicates 500 FPM plus UP and altimeter shows a climb trend, call positive rate. Confirm positive rate and call gear up. Monitor each flap setting desired on flap indicator.

- 18° FLAP TAKEOFF

  - At V2 + 10 knots, call flaps 8°.
  - At V2 + 20 knots, call flaps UP.

- 8° FLAP TAKEOFF

  - At V2 + 10 knots, call flaps UP.

- 3° FLAP TAKEOFF

  - At V2 + 10 knots, call flaps UP.

Hand Brake Pressure - ZERO. If auto-brake pressure remains ON after gear retraction or if the hand brake pressure indicator is inoperative, the hand brake handle must be pulled and released after takeoff.

No. 1 Auxiliary Hydraulic Pump - OFF/CHECK PRESSURE. Check both hydraulic systems pressures normal (3,000 PSI). Check quantity indicators in "green".

Speedbrake Collar - DOWN. Collar must be placed in the DOWN locked position for enroute operation. This limits speedbrake operation to 20° during flight.

Fuel Dip/TTC - ARMED BOTH. Normally select one engine to ARM BOTH. Pause and check engine parameters. Select the other engine and check parameters.

Icing Systems/Ignitors - AS REQUIRED. Monitor and call for engine and wing/tail anti-ice as desired.

- Check engine anti-ice ON/OFF.
- Check wing/tail anti-ice ON/OFF.
- Check windshield heat HIGH/LOW.
- Check 5 pitot heaters ON. Check meters and lights extinguished.
- Turn ignition OFF after first power reduction at 1,000 feet.
- Call OAT if below 10°C and in clouds.

Air Conditioning Panel - CHANGEOVER/CROSSFEED CLOSED (CHECK M.I.).

- Changeover at 3,000 feet AGL.

- Advise Captain of intentions and wait for okay.

- When changeover is complete and crossfeed is CLOSED, advise the Captain.

(cont'd.)

AFTER TAKEOFF (cont'd.)

Air Conditioning Panel - CHANGEOVER/CROSSFEED CLOSED (CHECK M.I.). (cont'd.)

- At 3,000 feet AGL:
  - Select No. 1 isolation valve to OPEN.
  - Select No. 2 isolation valve to OPEN.
  - Select No. 2 MAC valve to OPEN.
  - Check surge on mains pressure gauge as right engine air is introduced to system, then CLOSE air delivery valve, and IMMEDIATELY select No. 1 MAC valve to OPEN.
  - Check slight surge on mains pressure gauge as left engine air is introduced to system, then CLOSE crossfeed valve.

    NOTE: At this time, select any anti-icers that are needed.

APU - AS REQUIRED. Prior to shutting down the APU, the F/O should check with the Captain. Observe fuel valve CLOSED, check EGT and fire warning. APU may be shutdown prior to 10,000 feet if cooled.

Pressurization - CHECK. Check cabin rate of climb at 500 FPM and set for cruise altitude.

Fuel Transfer - AS REQUIRED. The Captain will initiate fuel transfer by delegating the F/O to start transfer from the proper tank.

It is recommended that the Captain operate the main transfer valves during fuel transfer due to the workload on the F/O.

On the Captain's command, the F/O will initiate fuel transfer when the main tanks indicate 8,000 lbs. Run No. 1 transfer pump on eastbound operations and No. 2 transfer pump on westbound operations. Operate both transfer pumps when center tank quantity is below 2,000 lbs. Callout the tank from which fuel is being transferred. Callout the appropriate tank for which fuel transfer has been terminated.

Seat Belt/No Smoking - AS REQUIRED. Turn the No Smoking sign OFF after first power reduction. Turn the seat belt sign OFF at Captain's discretion.

Landing Lights - OFF/RETRACTED. Turn the landing, taxi, turn-off, and nose lights OFF at 10,000 feet. Run lights according to policy set in preflight checklist. All lights should be extinguished at 10,000 feet.

CLIMB (Not on Checklist)

A callout shall be made passing through 18,000 feet so that altimeters can be set to 29.92. Altimeters should be cross-checked at this point.

A callout should be made when reaching 1,000 feet below the last assigned altitude on climb: 500 FPM is the target climb rate for the last 1,000 feet.

Severe turbulence should be avoided whenever possible during climb or other flight regimes. If it cannot be avoided or is encountered unexpectedly, the best speed range from all handling and strength aspects is 250-270 knots IAS.

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CRUISE (Not on Checklist)

CRUISE SPEEDS

Upon reaching cruise altitude, the airplane should be smoothly and gradually leveled and accelerated to 300 knots below FL270 and M.74 above FL270. Check cruise charts for fuel flow, speed, and Mach.

If the overspeed warning bell rings during cruise or thereafter, slow the airplane to below maximum allowable speed.

Observe 250 knots speed limitation below 10,000 feet and turbulence penetration speeds as necessary throughout the cruising regime.

YAW DAMPER OPERATION

The rudder channel of the autopilot may be engaged separately for yaw damping by placing the autopilot switch to DAMPER position.

The switch is located on the right section of the autopilot panel.

To disengage the yaw damper, press the pilot's or copilot's disconnect button on the control wheel, or place the yaw damper switch to OFF.

NOTE: The yaw damper switch must be OFF (disengaged) prior to takeoff and landing.

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DESCENT (Not on Checklist)

GENERAL

The descent profile presents many variables and should be carefully planned and executed. Anticipating descent requirements and initiating descents at the proper time and distance out (subject to ATC considerations) will result in arriving at the airport at proper altitudes, speeds and configurations, and with appropriate checklists completed.

Set the pressurization controller to landing field elevation.

Observe the 250 knot restriction below 10,000 feet.

Approach and landing techniques as detailed in text and profiles in the Chapter 18, TRAINING of this manual apply equally to line operation.

HOLDING PROCEDURES & TECHNIQUES

Maximum ATC holding speeds for turbojets are 200 knots below 6,000 feet, 21 knots above 6,000 through 14,000 feet, and 230 knots above 14,000 feet. The holding fix should initially be crossed at or below maximum holding speed with speed reduction effected within 3 minutes prior to ETA, over the fix.

PASSENGER CONFIDENCE MANEUVERS

Smooth turns and lesser bank angles plus careful changes in climb and descent attitudes will always give the passengers a good ride and a feeling of confidence in the flight crew. This is equally true when flying manually and when controlling the autopilot, regardless of mode.

GROUND PROXIMITY WARNINGS

If a **TERRAIN** warning is activated, the crew must immediately focus its attention on terrain proximity and make a rapid determination as to the validity of the warning. If the crew cannot immediately determine that the warning is invalid, the pilot must rapidly apply maximum power while simultaneously rotating to an attitude of 15° nose-up. The warning will cease when the dangerous situation no longer exists. If the warnings do not stop, the pilot must climb until terrain clearance is assured and a positive determination can be made of the cause of the warnings.

These actions altering the flight path to stop the warning should be initiated immediately; smoothness should be of no concern if adding maximum power and rotating the aircraft is determined to be necessary to gain terrain clearance. They are especially appropriate under the following conditions:

- While conducting approaches over unlighted terrain; maneuvering for an approach at night; or in instrument conditions.
- When established on an approach where vertical guidance is unreliable.
- In maneuvering for, or established on, an approach when ambient conditions such as turbulence or windshear cause the approach to become unstabilized.

(cont'd.)

DESCENT (Not on Checklist)
(cont'd.)

GROUND PROXIMITY WARNINGS (cont'd.)

If a **GLIDESLOPE** warning is activated between the altitudes of 1,000 feet and 150 feet AGL, application of power sufficient to bring the airplane back up toward the glideslope beam center will cancel the warning when it is less than 1.3 dots below the glideslope. The allowable deviation increases to 2.7 dots at 50 feet AGL. This deviation causes an off-scale deflection on the glideslope deviation scale.

DESCENT

Pressurization - SET. Snub rate knob. Set controller initial descent flight level or altitude. Adjust rate for 300 FPM DOWN. Fly the cabin "down".

Circuit Breakers - CHECKED. Check radio rack, left rear, and right side circuit breakers.

Landing Data & Bugs - CHECK/SET. Complete crew briefing and review landing data. Set altimeter to DH or MDA. Set radio altimeter according to Company policy. Set airspeed bugs. The F/O shall verify all Captain callouts by repeating numbers. Obtain ATIS and verify numbers.

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IN-RANGE

Fuel Panels - SET. Verify four boost pumps ON and crossfeed CLOSED. Verify long range fuel tanks secured. Check three shutoff valves CLOSED and four pumps OFF. Delay the in-range check until all fuel transferring is completed.

Altimeters - SET/CROSS-CHECK. The Captain will callout barometric setting and altitude and the F/O will verify altimeters by calling out barometric setting and altitude.

Hand Brake - OFF. The F/O will callout hand brake pressure ZERO or actual pressure. If pressure is indicated, ascertain that it drops to ZERO after gear extension.

Accumulators - PRESSURE CHECK. Check pressure at 3,000 PSI on System No. 1 and No. 2. Charge, if necessary.

Fuel Dip/TTC - TTC ONLY.

Pressurization - SET LANDING. Make final adjustment to the controller by setting the airport pressure attitude. Do not land pressurized.

Landing Lights - 10,000 FEET/ON. Normally, operate taxi and turnoff lights. Operate landing and nose lights for landing.

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BEFORE LANDING

Shoulder Harness - FASTENED.

Anti-Ice Systems - AS REQUIRED. Turn wing/tail anti-ice OFF prior to touchdown or a missed approach. Engine anti-ice ON or OFF as conditions warrant. Check 5 pitot heaters ON and check ammeters. Check windshield heat ON and HIGH/LOW.

Speedbrake - FWD/COLLAR UP.

Seat Belt/No Smoking - ON. Operate Seat Belt/No Smoking sign at Captain's discretion.

Landing Gear - DOWN/3 GREEN/PRESSURE. Command gear DOWN. Check red gear unsafe light extinguished. Observe hydraulic quantities and pressures.

Anti-Skid - ON/CHECK. Observe four releases. System may be tested if operation is in doubt. At this time, observe hand brake pressure for ZERO indication, if pressure was up on the in-range checklist.

No. 1 Auxiliary Hydraulic Pump - ON. Observe No. 2 AC bus for current draw or excessive load. During nighttime operations, a dimming of the lights may be experienced.

Hydraulic Pressure & Quantity - CHECK. Observe System No. 1 and No. 2 indicating 3,000 PSI and in the "green".

Flaps - LANDING. Select landing flaps (26°/45°) and observe indicator indicate selected flap setting.

Ignitors - RELITE/CHECK LIGHTS.

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LANDINGS (Not on Checklist)

NORMAL LANDING

The sequence below describes a landing approach from the downwind leg, as typical. Actually, approaches are made from numerous intercept angles and altitudes. Program speed and configuration changes so as to be stabilized in the approach slot 500 to 800 feet above field elevation for a straight-in approach, 300 feet from a circling approach.

Normally, a pattern altitude of 1,500 feet above field elevation is used. Prior to or when entering downwind leg, 18° flaps should be extended. Target speed at this time would be the appropriate gross weight chart speed for 18° flaps. This speed provides sufficient margin above stall speed to allow banks of as much as 45°. (Actually, flights during normal flight regimes should never exceed 30°.)

Opposite the approach end of the runway, extend the landing gear and complete the LANDING checklist. Downwind or when turning on base leg, flaps should be positioned to 26° and a normal descent (such as 700 FPM) continued. Target airspeed again is specified as chart maneuver speed for 26° flaps.

On base or turning onto final approach, flaps should be extended to 45° and final approach speed established at "bug" (Vref) plus 10 knots plus any additives necessary (1/2 of gust factor, 1/2 of headwind component. Speed should not be less than Vref + 10 or more than Vref + 20 knots).

As turn is made to final, the airplane should be flown into the "approach slot" with the touchdown target 1,000 feet beyond the runway threshold. Proper glideslope angles (2-1/2° to 3°) and sink rate (500 - 700 FPM) must be established early in the approach to avoid high sink rates close to the ground. While high sink rates may be required on initial approach, they cannot be tolerated at low altitude. Also, power must not be reduced to the extent that the engines "spool down". It must be remembered that a spooled-down engine can take 5 to 8 seconds to produce maximum power. A high sink rate and a spooled-down engine are a dangerous combination. On final approach, sink rates in excess of 1,000 FPM below 1,000 feet, and 700 FPM below 300 feet, a go-around should be made rather than continue with a poor approach.

Do not use excessive aileron control (15° yoke travel) as this brings up spoilers, tends to induce dutch roll.

Target flare speed (Vref plus gust factor, minimum Vref + 10 knots) should be maintained until start of flare, further dissipating the plus factor as descent is checked. Smoothly reduce thrust to idle and complete landing. If landing does not occur shortly after flare, back pressure should be eased off to "put the airplane on". Protracted holding off is strongly discouraged and emphasis is on early contact to conserve runway.

After touchdown and with both main gears on the runway, deploy the spoilers and engage thrust reversers while smoothly lowering the nose to the runway. Thrust reversers should not be normally operated at excessively high power during the landing roll and should be placed in idle reverse at 70 knots and cancelled at 50 knots. The pilot in the left seat will extend the speedbrakes/lift dumpers.

(cont'd.)

LANDINGS (Not on Checklist) (cont'd.)

NORMAL LANDING (cont'd.)

The pilot not flying should guard the control column as soon as the nose wheel contacts the runway to prevent nose rise during spoiler deployment and reversing. (Care should be exercised against excessive forward pressure which could cause a lifting effect on the main wheels.) After returning engines to forward thrust, retract spoilers, retract flaps to 18° for taxi. Complete the AFTER LANDING checklist.

Brakes are only to be applied after the wheels have spun up, normally during the latter part of the landing roll to prevent excessive brake wear and overheating. Nosewheel steering should be restricted to the lower rollout speeds.

Excessive aileron action resulting in assymetrical spoiler deployment will cause wing lifting. Use proper aileron (maximum 15° wheel travel) and rudder inputs as necessary to keep aircraft straight during rollout. (See Crosswind Landing discussion below.)

CROSSWIND LANDING

On final approach, establish a crab angle to maintain aircraft on the extended centerline of runway. Maintain crab angle until just before touchdown, then use rudder to align aircraft with the runway.

Keep wings as level as possible. Use only enough bank to maintain zero drift, touching down on the upwind wheels. Do not hold off downwind wheels. Prompt runway contact will greatly aid in stabilization on rollout.

After touchdown and during rollout, aileron correction should only be that necessary to maintain wings level. Maximum input is limited to 15° yoke travel to prevent downwind spoiler retraction and resultant wing lifting.

Use spoilers, reverse, and brakes as in a normal landing.

ONE ENGINE INOPERATIVE LANDING

When landing with one engine inoperative, approach and landing techniques are similar to those with both engines operating except that landing is made with 26° flaps and final approach speed is flown at BUG speed (1.3 Vs for 26° flaps) + 10 knots + additives. After touchdown, use single-engine reversing, correcting with brakes as necessary for asymmetrical thrust.

A single-engine landing with 26° flaps will require approximately 750 feet more DRY runway and 875 feet more WET runway as compared to landing with 45° flaps.

(cont'd.)

LANDINGS (Not on Checklist) (cont'd.)

ONE ENGINE INOPERATIVE LANDING (cont'd.)

The following table indicates actual requirements. The computed lengths apply to airport elevations up to 3,000 feet for 0 wind and headwind conditions.

Landing Weight	26° Flap Landing Distance	
	Dry	Wet/Slippery
78,000	6,875'	7,910'
77,000	6,750	7,765
75,000	6,550	7,535
73,000	6,350	7,305
71,000	6,175	7,105
69,000	6,000	6,900
67,000	5,825	6,700
65,000	5,650	6,500
63,000	5,500	6,325
61,000	5,350	6,155
59,000	5,200	5,980
57,000	5,050	5,810
55,000	4,900	5,635

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AFTER LANDING

Radar/Transponder - STANDBY.

Flaps - AS REQUIRED. Select flaps 18° and check pressure 3,000 PSI and indicating in the "green". Position flaps to 0° upon arrival at the gate.

Trim/TPI - RESET/+2. Reset rudder/ailerons to ZERO. Reset TPI to +2.

Speedbrake/Anti-Skid - FWD/OFF. Check four "blanks" and brake temperature.

Safety-Discharge Valve - OPEN. If valve not open, select higher cabin altitude.

No. 1 Auxiliary Hydraulic Pump - OFF/CHECK PRESSURE. Check pressure 3,000 PSI and in the "green".

Anti-Collision Lights - OFF.

Anti-Ice - OFF. Turn engine anti-ice OFF.

Ignitors - OFF/HIGH-LOW.

Windshield Heat - AS REQUIRED. For intermediate stops, select ON and HIGH/LOW; otherwise OFF and OFF.

Pitot Heat - OFF.

APU/Air Conditioning - AS REQUIRED. The Captain may call for mains pressure to be zeroed. Select MAC valves to APU, one at a time, or air delivery valve CLOSED if APU supplying air. The F/O will start APU and check APU on-the-line on good generator. Check fire warning in AUTO. Normally, taxi-in on engine bleeds. Monitor APU during all starts.

Landing Lights - OFF. At night, lights will be operated by the Captain or delegated at his/her discretion.

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SHUTDOWN

Parking Brakes or Chocks - AS REQUIRED.

Air Crossfeed and Delivery Valve - CLOSED.

MAC Valves - APU.

Fuel Pumps - OFF.

INS - OFF.

Emergency Lights - OFF.

Crew Oxygen - OFF.

Ground Cooling Fan - AS REQUIRED.

APU - OFF.

Battery - OFF.

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COLD WEATHER OPERATIONS

GENERAL

The problems associated with cold weather operation are primarily those concerned with low temperatures and with ice and snow on the airplane and runways. The majority of operating difficulties are encountered on the ground. This section contains those procedures that are in addition to the Normal Operating Procedures except where repetition is necessary for emphasis, clarity, or continuity of thought.

EXTERIOR SAFETY INSPECTION

Allow extra time to complete an even more careful walk-around inspection than normal, calling any needs for deicing to the attention of ground personnel AS SOON AS POSSIBLE TO AVOID DELAY. Plan to be aboard the aircraft in sufficient time to have cabin temperature as comfortable as possible when passengers board.

During walk-around inspection, check the following areas:

- Inspect airplane for accumulations of snow, frost, or ice on wings, tail, fuselage, and control surfaces.

- Inspect the space between movable control surfaces and at hinge points. Check wheels and any movable devices between such surfaces. Operate flight control surfaces, tabs, and various flaps, where practicable.

- Check landing gear struts, actuating cylinders, locking mechanism, wheels and brakes, gear cover doors, etc., for freedom from ice, snow, mud, frost, etc. Check landing gear micro-switches for freedom from ice. Check tires and struts for proper inflation and insure that the tires are not frozen to the ground or to the chocks.

  NOTE: Sufficient heat sometimes builds up in brakes, wheels and tires following a long taxi after landing to melt snow and ice. This later freezes, causing tires to freeze to the ground.

- Check the probability of free opening of all doors, compartments, etc.

- Check pitot and static ports clear. See that all fuel, oil, and other fluid vent lines and breathers are free of ice, snow, etc.

- Check antennae, radomes, etc.

- Check for proper oxygen bottle pressure during colder weather.

- The LP fan stage can be checked for free rotation if it is felt that it may be ice imbedded. Snow or freezing rain blowing into the engine inlets will melt and form ice, blocking rotation. Under no conditions should the engine be started until rotors are freed; otherwise, damage to the engine will result.

- Check flight, powerplant, and other instruments to degree practicable.

- Check all anti-icing and deicing systems practicable, including pitot heat, windshield wipers and heat, and inlet heating systems.

COLD WEATHER OPERATIONS (cont'd.)

EXTERIOR SAFETY INSPECTION (cont'd.)

- The wing and tail anti-icing system should not be operated on the ground, except for brief tests, due to the excessive heating supplied to leading edge ducts. In known or forecast icing conditions, airframe anti-ice should be turned on at 1,000 feet AFL after reducing engine power to the climb setting. In the event that anti-icing is required prior to reaching 1,000 feet, it is permissible to turn on airframe anti-ice at 400 feet AFL.

  Turn this system on only after takeoff. After the pneumatic changeover, following climb power:

  - check functioning of wheel brakes.
  - check cabin heating as practicable.

APU STARTING LIMITATIONS

Continuous starter cranking must not exceed one minute. If the APU fails to start, the start must be cancelled by moving the APU control switch to OFF. Four minutes must be allowed to elapse before the next start attempt is initiated.

A cooling period of 30 minutes is required after four start attempts.

ENGINE START & TAXI

Coldsoak Start Procedure: Refer to ENGINE STARTING (Not on Checklist) in this chapter.

Keep engine and taxi operations to a minimum on ice or snow covered ramps. In addition to normal "blasting" dangers when pulling away from the ramp, ice and snow being blown about constitutes a hazard to personnel and equipment. Also, your jet may "ice up" adjacent aircraft and ground equipment.

Do not use so much power to start into a turn that the turn cannot be stopped without excessive braking. Anticipate slow or no response in nosewheel steering so that action can be taken in time.

Avoid taxiing in deep snow; more power is required, steering is more difficult and there is always the danger of becoming mired down. Too, strain on the gears is increased and snow may lodge in brake assemblies with subsequent freezing. Taxi at slow speeds with caution, remember that braking and nosewheel steering may be poor or non-existent. Watch for snow banks, runway and taxi lights, etc. Spotty ice cover on taxi surfaces may be difficult to see at night or during bright sunshine when glare of white snow makes it difficult to see. Ice may be covered by a thin layer of light snow. Exercise care when taxiing behind jet aircraft when snow is falling. Heat from the jet blast ahead may cause snow to freeze on your aircraft.

Even though the latest weather reports have not indicated a hazardous runway condition, the approach end of the runway is usually more slippery than other areas because of the melting and refreezing of ice and snow after each aircraft takeoff and landing, plus the normal kerosene, lubricating oil, and rubber deposits.

COLD WEATHER OPERATIONS (cont'd.)

TAKEOFF & CLIMB

It is the Captain's responsibility to exercise precaution in taking off under any freezing precipitation conditions. Wing surfaces should be visually inspected before takeoff if snow or freezing precipitation is in progress and time has elapsed since deicing. If the elapsed time since deicing exceeds 20 minutes, careful examination of the surfaces should be conducted to determine the extent of accumulation and to assure that the takeoff can be made safely and in compliance with existing FAR's.

Before takeoff, be sure runway is free of such hazards as snow drifts, glazed ice, and ruts. When taking off from any icy runway, maintain directional control with engines and rudder rather than depending on nosewheel steering.

Snow, slush, or standing water may have the viscosity and resistance of molasses. They create wheel drag that increases takeoff distance considerably.

No attempt should be made to takeoff with a load of ice or snow. Ice or snow on the wing will change the shape of the airfoil and disturb the flow of air over the wing, reducing available lift and airspeeds. Any change in control surface shape may result in flutter. Don't assume that a light snow will melt or blow off during taxi-out or the takeoff run. Even if it does, it may reveal ice or frost beneath.

Make sure that engine power does not exceed the maximum allowable as cold, dense air enters -- rated P7 plus 3" or rated EPR plus .1.

After taking off from a snow or slush covered runway, operate the gear and flaps as practicable to prevent freezing in the retracted position. Slush freezing on the uplocks may prevent them from engaging until the ice is broken clear by continued pressure and increased wheel well temperatures with the doors closed. Maintain climb airspeeds below maximum retraction speed while doing this.

Monitor all applicable anti-icing and deicing systems as soon as practicable.

CRUISE

Engine intake anti-icing systems should be operated in anticipation of operating in icing conditions. If, however, ice accumulates before the heat is turned on, good operating practice is to turn on only one engine's system at a time in case of flameout from the melted ice.

Turn on ignition prior to turning on engine or airfoil anti-icing if ice is already accumulated. Use ignition during severe icing and landing with potential "flameout" conditions.

APPROACH AND LANDING

Turbine engines create no problem of overcooling during descent, so long as oil temperature minimums are maintained. Pilots will note that descent power may have to be increased to maintain sufficient anti-icing temperatures.

Plan instrument approaches ahead with respect to minima. Review missed approach procedures. Remember that with lighting aids inoperative or obscured by snow, minima may be changed.

COLD WEATHER OPERATIONS (cont'd.)

APPROACH AND LANDING (cont'd.)

Wing anti-icers should generally be turned off at a time equivalent to passing the outer marker inbound to prevent excessive heat build up.

Watch out for possible tailplane icing during the landing approach. Ice formed on the tailplane may be of an amount that will not aerodynamically affect the airplane until flaps are lowered to the approach or landing position. At this time, a downward pitching may occur which must be counteracted by application of power and retraction of flaps to a lesser setting. Judicious use of the anti-icing systems and stabilizing flap settings and airspeeds farther out will guard against this danger.

(Remember that maximum icing occurs when OAT is between 0° and -10°C. The cockpit temperature gauge may have errors. Watch those temperatures just above freezing as well as those below.)

If the aircraft has a visible accumulation of ice, approach speeds should be somewhat higher than normal. Wet or icy runways require longer stopping distances.

Wind shear on the approach or near the threshold is unpredictable, and intensity will vary with wind speed. Wind shear on the tail at let down tends to produce runway overshoot; on the nose, it may cause a higher rate of sink than anticipated.

Surface winds are hazardous because they consist of countless eddies and currents, continually changing in velocity and direction. Unfortunately, the pilot cannot predict the exact wind speed he will encounter during the approach and landing flare. While the wind condition may be prevalent during other months of the year, in the winter it may be compounded by blowing snow, and snow and ice-covered runways.

Under normal approach procedures, the pilot will increase his approach speed to insure that he will not encounter an uncontrollable sink rate or that the aircraft will not stall if a gust suddenly plays out, maintaining this correction (target speed) until just before touchdown.

The pilot will often find it impossible to judge height above the ground because snow itself will not serve as a reference. A runway may be clearly visible from directly above. During the approach, however, the runway may "disappear" because the white runway with its plowed banks and the white terrain all blend together. Visibility is impaired, not only from the glare, but the usual visual clues are hard to distinguish. Snow contours are especially difficult to differentiate at night and on heavily overcast days because terrain appears flat, a condition called "flat light". Lighting at night plays tricks when obscured or reflected by snow moving through the air or lying on the ground.

Drifting snow also reduces visibility. Winds of 9 to 12 MPH raise the snow a few feet off the ground, and the blowing snow obscures surface objects such as ruts and runway markers. This is particularly true where there is nothing to break the wind. Winds of 15 MPH raise snow high enough to obscure buildings. Fine blowing snow suspended in the air by winds of 20 knots or more reflect and diffuse sunlight, greatly reducing visibility.

COLD WEATHER OPERATIONS
(cont'd.)

APPROACH AND LANDING (cont'd.)

After landing, brakes and nosewheel steering may be ineffective. Plan on aerodynamic braking. Reverse power should be applied evenly to prevent unbalanced thrust on one side causing sideways sliding. Be alert for asymmetrical braking if one system fails to reverse. Watch for a restriction to vision at the low-speed end of the landing roll, when reversing tends to throw up dry snow, slush, or standing water. Go to idle reverse at 80 knots; cancel reverse at 70 knots.

If wind and/or reverse blast is blowing snow across the runway or around the windshield, obscuring markers and runway limits, be prepared for dubious and deceptive landing conditions.

Landing on slush-covered runways is another problem. The first 2,000 feet of roll is the most critical since the airplane tends to hydroplane at high speeds. Wheel braking during this period would be ineffective because the wheels would not be making contact with the runway. If the airplane should begin to skid or yaw, directional control must be maintained by use of the rudder until the tires make solid contact with the runway suface and begin to maintain control. Then wheel braking can be used. Reverse thrust under skidding conditions can increase the rate at which an airplane slides off the side of the runway due to the sideward component. If the sideways skid is approaching uncontrollability, reverse thrust should probably be reduced or eliminated, if practicable.

When the BAC 1-11 is landed in slush conditions, wing flaps should not be completely retracted after landing until a ground inspection and removal of any accumulated slush is accomplished.

AFTER LANDING

Even though the landing worked out well, don't drop your guard until safely stopped at the ramp. All the cautions discussed on taxi-out also apply here plus:

- Turn off all anti-icing and deicing systems not needed during ground operation.

- As the ramp area is approached with snow and ice covered surfaces, generally do not cut the inside engine until the turn is completed. Keep down the power and the speed at the ramp.

- Conserve aircraft electrical power; keep systems which must operate off batteries to a minimum time.

- After any approach where it is suspected that ice may have accumulated on the aircraft, or after a landing on a runway covered with slush or loose snow, the flight crew should inspect the aircraft prior to departure. Particularly note wheels, landing gear area, wheel wells, tail surfaces, engine inlets, pitot and static ports, etc. This is especially true at non-maintenance termination point, where the terminating crew can spot problems in time to prevent delays on the next origination.

- Check the aircraft also if it is suspected that materials larger than sand grains have been used on runway, ramp, or taxiway surfaces. Any of these and even excessive sand can damage aircraft components, engine intakes and rotors, etc.

COLD WEATHER OPERATIONS (cont'd.)

OPERATING RESTRICTIONS FOR TAKEOFFS AND/OR LANDINGS

ALLOWABLE DEPTHS	TURBOJET AIRCRAFT
Dry Snow	2 inches
Wet Snow	Any amount may halt operations, subject to Captain/SCC decision.
Slush/Standing Water	*1/4 inch
Finger Drifts	Of 4 inches or more should be reported.
AREAS	
Runways must be plowed	Straight, full width, full length. Exception: If not plowed full length, takeoff and landing weight must be predicated on length of runway plowed. If not plowed full width, takeoff permitted subject to Captain's decision. May be plowed to a minimum of 150 feet wide for landing if weather conditions are 500-1 or better and pilot is advised that runway is not plowed full width.
Taxiways must be plowed	Full width (minimum 75 feet)
Snow banks	3 feet maximum along sides of runways and taxiways, tapered at 45° angle 0 to 3 feet. None permitted at either end of runways.
Runway lights	Check Operations Specifications Takeoff Minimums. Runway lights required for night operations. During failure of normal systems, refer to "Runway Lighting - Auxiliary Lighting Policy". Flare pots not authorized.
Ramp, Walkways	In condition for passengers to enplane and deplane.
Wet or Slippery Runways	15% additional landing runway requirement on dispatch basis (turbojet).
MATERIALS	
Sand, Finely Ground Cinders, Urea**	Can be used.
Salt-treated, Corrosive	Cannot be used.
Lumpy, such as Cinders, Frozen Sand, Larger than Sand Grains, etc.	Cannot be used.
WIND	
Crosswind Component	Maximum 25 knots (from wind gust factor value). On landing, 10 knots with visibility less than 3/4-mile or RVR 4000 on runways less than 8,000 feet.
Downwind Component	Maximum 10 knots (from wind gust factor value).

*Under conditions considered favorable by the Captain and Dispatcher, operations may continue up to, but not to exceed 1/2 inch. The conditions that must be considered by the Captain and flight crew are wind direction, velocity, runway of sufficient length, amount of runway covered by the condition, the consistency of the slush, etc.

**If Urea has been used as a deicing agent on top of snow or ice 1/2 inch or more in depth, all operation of Company aircraft is to stop until the runway has been broomed or plowed with resulting slush or snow depth within Company's specifications.

COLD WEATHER OPERATIONS (cont'd.)

OPERATING RESTRICTIONS FOR TAKEOFFS AND/OR LANDINGS (cont'd.)

If Urea has been applied with a mixture of sand on top of snow or ice with a depth less than 1/2 inch, operation may continue, provided the braking action report is no less than POOR and slush depth no greater than 1/4 inch.

Definitions

Dry Snow: Snow with limited water content. Normally flies into a "cloud" when kicked and dissipates rapidly. Outside temperature is generally below 28°F (-2°C). Dry snow can become wet if exposed to bright sun.

Wet Snow: Snow with sufficient moisture content so that it packs easily, will "roll up" when a foot is pushed through it. Does not fly into a "cloud" when kicked. Packs down when stamped with a foot, but has no tendency to splash. If there is any tendency to splash, it must be considered slush. Wet snow quickly becomes slush under certain conditions. If in doubt, be conservative -- treat it as slush.

Slush: Partially melted snow with high water content. Will splash when a vehicle is run through it or when stamped with a foot.

Runway Lighting - Auxiliary Lighting Policy

In the event of normal runway/threshold light failure, Company operations may be conducted in accordance with the policy set forth herein.

Battery operated white, yellow, or amber steady lights may be utilized. Under NO circumstances may open flame, flare pot units be used.

Takeoffs may be made under the following conditions:

- Daylight: In accordance with Operations Specifications Takeoff Minimums. If runway edge lighting is required, the policy for "Landing" will apply.

- Night: The policy for "Landing" will apply.

Landings may be made under the following conditions:

Threshold light must be substituted for, one for one, in any instance where runway edge lights are required.

Runway length may be varied according to the number of auxiliary light units available if:

- the Computerized Takeoff Weight System is available, or

- a qualified Company Performance Engineer is available to provide the appropriate performance information.

Runway edge light substitution is required to a degree which will allow identification of, and orientation to the runway to be used in the meteorological conditions which exist at the time.

(cont'd.)

COLD WEATHER OPERATIONS (cont'd.)

OPERATING RESTRICTIONS FOR TAKEOFFS AND/OR LANDINGS (cont'd.)

Runway Lighting - Auxiliary Lighting Policy (cont'd.)

Runway edge light substitution will be at the following intervals:

10,000 foot ceiling, visibility 8 miles, or better.	Threshold lights - all. Runway edge - one each 500 feet, each side of runway.
Less than 10,000 foot/8 miles to 1,000 foot ceiling, visibility 3 miles.	Threshold lights - all. Runway edge - one each 400 feet, each side of runway.
Less than 1,000 foot/3 miles to alternate minimums.	Threshold lights - all. Runway edge - one each 200 feet first 1,600 feet, and one each 400 feet thereafter, each side of runway.
Less than alternate minimums to circling minimums.	Threshold lights and runway edge lights, one for one.

Operation below circling minimums with auxiliary lighting is not authorized.

The values in this policy presume all other operating conditions to be favorable. The Captain and Dispatcher of a specific flight may modify the policy towards a more conservative position as they deem necessary. No more liberal lighting standard may be used.

SEVERE PRECIPITATION

RADAR POLICY

Dispatch

Operative radar is required for dispatch under conditions of IFR or night VFR whenever current weather reports (not forecasts) indicate thunderstorms or other hazardous weather conditions, which can be detected by airborne weather radar, may be encountered along route to be flown. Radar is intended primarily as a storm avoidance aid rather than a storm penetration aid.

A flight may be dispatched with radar inoperative if an alternte routing can be selected that will be clear of hazardous or thunderstorm activity.

Enroute

In the event that airborne weather radar becomes inoperative enroute, the flight may continue provided that (1) an alternate route clear of thunderstorm or hazardous weather condition can be taken, or (2) in the event the aircraft must continue into thunderstorm conditions, it must be slowed to correct airspeeds in accordance with the aircraft operating limitations, and Company thunderstorm policies and procedures applied to the extent possible.

Be aware of the effect of areas of heavy precipitation masking returns from storms farther away. While the X-band radar is excellent for detecting storm areas, the radar energy is attenuated by rainfall, the degree of degradation increasing rapidly when the precipitation between the storm cell and the radar antenna increases from "moderate" to "heavy". When the aircraft is in an area free of precipitation the radar is excellent for detecting and evading turbulence, but once in rainfall, its usefulness is diminished. It is not as satisfactory for use as a storm penetration aid.

ICING CONDITIONS

It is the Captain's responsibility to exercise precaution in taking off under any freezing precipitation conditions. Wing surfaces should be visually inspected before takeoff if snow or freezing precipitation is in progress and time has elapsed since deicing. If the elapsed time since deicing exceeds 20 minutes, careful examination of the surfaces should be conducted to determine the extent of accumulation and to assure that the takeoff can be made safely and in compliance with existing FAR's.

Engine Anti-Ice:

The use of engine anti-icing is required during all ground and flight operations with icing conditions or visible moisture such as rain, fog, or high humidity with a temperature of (+10°C) or lower.

When holding on the ground in conditions below +10°C with fog or rain and with engine anti-icing selected ON, it is recommended that the engines be accelerated to approximately 90% HP RPM for 3 to 4 seconds and at intervals of not more than 8 minutes. This will insure that rotor/stator icing at low engine speeds will be kept within acceptable limits before takeoff. Maximum engine anti-ice pressure is 65 PSI, no minimum.

SEVERE PRECIPITATION
(cont'd.)

ICING CONDITIONS (cont'd.)

Airframe Anti-Ice:

The following are the minimum temperatures to be read on the anti-ice system wing and tail gauges for adequate anti-ice protection:

- Light and Moderate Icing 150°C
- Severe Icing 180°C

The maximum temperature limit for airframe anti-icing is 238°C.

No airframe anti-icing is required for takeoff, but in known or forecast icing conditions, airframe anti-icing is normally selected following changeover from APU bleed at 1,000 feet. If anti-icing is necessary prior to 1,000 feet, it is permissible to changeover above 400 feet and at takeoff power. When in use, all anti-ice switches are normally on.

NOTE: Select all four switches to ON when initiating anti-ice.

The changeover from APU bleed must be completed and duct pressure stabilized before airframe anti-icing is selected ON.

Inflight Icing:

Inflight, if any indication of icing is noted, engine, wing, and tail anti-icing must be switched ON. If no ice accretion can be seen on the hot rod, tail and wing (and, possibly engine), anti-icing may be switched OFF, but the hot rod must be monitored at frequent intervals. Ice accretion on the hot rod should be shed periodically to ascertain if icing conditions persist. After icing conditions have ceased, tail, wing, and engine anti-icing should be switched OFF.

It should be noted that engine anti-icing may be required when airframe icing is not indicated or anticipated. This is especially true when making long, cool descents; even in cold haze conditions without clouds or visible moisture. Also, care should be exercised with extended holding at low power settings.

There should be no delay in selecting anti-icing when icing conditions are encountered. The hot rod should be frequently monitored for signs of icing. Failure to select, or late selection of engine and wing anti-icing, may result in engine malfunctioning due to ice shedding from engine intakes or the wings ahead of the engine. It is good practice to turn engine heat on first and turn it off last.

Rapid throttle lever movement in icing should be avoided.

Windshield Heat:

The windshield heat must be selected from LOW to HIGH if the temperature on the ground is -15°C or below, if in-the-air temperature is below -5°C, or if the underheat lights are on. If windows are cold-soaked, warm gradually by 10-second cycling between OFF and LOW for about one minute.

Pitot Heat:

Amperage should show approximately mid-scale. With failure of a pitot probe heater, switch should remain ON to heat stall vanes.

SEVERE PRECIPITATION (cont'd.)

OPERATIONAL RESTRICTIONS:

Takeoffs - Not Authorized in following:

- Moderate or heavy freezing rain.

- Moderate or heavy freezing drizzle.

- When wet snow, frost or ice are adhering to wings or control surfaces.

Climb - Not authorized to climb through known moderate icing conditions immediately after takeoff unless the airport of departure has ceiling and visibility minimums of at least 800 - 2, 900 - 1-1/2, or 1000 - 1 and conditions are suitable for the aircraft to return and land should severe ice be encountered.

Cruise - Not authorized to operate intentionally:

- In a known severe icing condition.

- In a known moderate icing condition except as provided during climbs and let-downs.

Over the Top Operation of Moderate and Severe Ice - Not authorized unless:

The top of the icing condition does not extend above the one-engine inoperative ceiling of the aircraft with the load being carried at the time and there is at all times an authorized airport within a 200 mile radius where the ceiling and visibility are reported not less than 800 - 2, 900 - 1-1/2, or 1000 - 1. However, the same minimums are required and the authorized airport must be within a radius of 100 miles, if the top of the icing conditions extends above the one-engine inoperative ceiling of the aircraft with the load being carried at the time.

Descent - Not authorized to let-down:

- Through known severe icing conditions, unless severe icing conditions are known to terminate at or above final approach altitude.

- Through known moderate icing conditions unless airport weather conditions are at least 800 - 2, 900 - 1-1/2, or 1000 - 1 or moderate icing conditions are known to terminate at or above final approach altitude.

Landings - Not authorized during following:

- Moderate or heavy freezing rain.

- Moderate or heavy freezing drizzle.

- Heavy, wet snow falling at the airport.

SEVERE PRECIPITATION
(cont'd.)

AIRFRAME ICING INTENSITY DEFINITIONS:

INTENSITY	ICE ACCUMULATION
Trace	Ice becomes perceptible. Rate of accumulation slightly greater than rate of sublimation. It is not hazardous even though deicing/anti-icing equipment is not utilized unless encountered for an extended period of time over one hour.
Light	The rate of accumulation may create a problem if flight is prolonged in this environment (over one hour). Occasional use of deicing/anti-icing equipment removes/prevents accumulation. It does not present a problem if the deicing/anti-icing equipment is used.
Moderate	The rate of accumulation is such that even short encounters become potentially hazardous and use of deicing/anti-icing equipment or diversion is necessary.
Severe	The rate of accumulation is such that deicing/anti-icing equipment fails to reduce or control the hazard. Immediate diversion is necessary.

SEVERE TURBULENCE

CLIMB, CRUISE, AND DESCENT

Severe turbulence should be avoided whenever possible. If it cannot be avoided, or is met unexpectedly, the best speed from all aspects of handling and strength is 250-270 knots IAS.

If known severe turbulence cannot be avoided, adjust airspeed, if necessary, to appropriate value well before entering the turbulence. In severe turbulence, indications of airspeed, mach number and altitude will fluctuate widely. The best procedure is to leave engine power unchanged and to maintain the aircraft attitude with no attempt to change speed or height. Long term speed changes should be monitored as far as possible and if necessary, altitude should be allowed to vary if this helps to maintain the best speed.

If severe turbulence is met unexpectedly, provided that the speed before the encounter was reasonably close to the best speed quoted above, the most efficient action is to maintain engine power and aircraft attitude. If speed was substantially too low, it should be carefully increased, relying more on correlation of engine power and aircraft attitude than on the airspeed indicator, machmeter and altimeter.

In cruise, if severe turbulence is widespread and continues, a change of altitude will often correct the situation, but any such deliberate change must be accomplished by a small change in power accompanied by a correspondingly small change in pitch attitude.

The autopilot should normally remain engaged, but the altitude hold must be OFF.

Except when it is necessary to change speed or altitude as above, the tailplane trim setting should not be altered, and pitch control should be by means of elevators alone.

HOLDING

For holding in severe turbulence at altitudes below 20,000 feet, lower speeds are permissible. The absolute minimum speed for holding in severe turbulence, which applies with the aircraft clean, is 240 knots IAS at 68,000 lbs. and below. If the holding pattern and other considerations permit, a higher speed is preferred.

USE OF FLAPS

Use of flaps is not recommended in severe turbulence, but if the flaps are at 8° or 18° and severe turbulence is met unexpectedly, they should be left at that setting and every effort made to hold speed between 180 and 210 knots IAS.

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BRAKING ACTION

"NIL" BRAKING ACTION

A. When a braking action report containing the word "nil" has been given by a Company source for a specific ramp, taxiway or runway which is to be used, no Company aircraft shall operate on that area until inspection has been made by knowledgeable airline or airport personnel, it has been determined that braking action is better than "nil", and that safety of operation should not be jeopardized.

If braking action is confirmed as "nil", no further operation shall be conducted until sanding, chemical treatment or other changes or actions take place, and such are determined to now permit a safe operation.

If braking action is determined to be other than "nil" as a result of the inspection, an operational message shall be issued allowing movement of Company aircraft.

In this case, aircraft operation on that surface may continue with extreme caution, pending more favorable braking action reports. For the first operation, crosswind components shall not exceed 5 knots and runway length available shall be at least equal to the equivalent of "wet runway" requirements for turbojets.

B. When a "nil" braking action report has been given for a runway and/or taxiways and ramps by other than a Company source and the Captain has reason to question the validity of such report, a landing can be made and taxi-in operations conducted at the Captain's discretion and subject to the following restrictions:

- The runway must be 8,000 feet or more in length for turbojet equipment.
- The crosswind component must be no greater than 5 knots.
- The Captain must not be on "high limits" restrictions in the aircraft type.

Thereafter, additional operations (taxi, takeoff, etc.) can be conducted subject to the paragraph "A" restrictions above and subject to the discretion of the Captain.

C. USAir considers that a braking action report affects only the runway or other area specified. Where a runway has a layer of new snow, or any meteorological change may have affected the previous condition, a new inspection must be made and a favorable report issued before operation can begin on that area.

Mu-meter or other braking measurements equating to "nil" shall have the same effect as "nil".

(cont'd.)

BRAKING ACTION
(cont'd.)

"NIL" BRAKING ACTION (cont'd.)

C. (cont'd.)

Company pilots reporting braking action should:

- Report "nil" only where there is no braking friction, even at low taxi speeds.
- In determining condition, take into consideration boundary and touchdown speeds, actual versus desired, etc.
- Give a short description, as practicable, of the condition of the runway, taxiway, etc., -- clear, ice, patchy, amount of surface covered, wet, dry, or wet snow, etc., and
- Report what you find, not what was given by other sources.

BRAKING ACTION REPORTS

Braking action reports will normally be given to flight crews in relative terms from Good through Fair and Poor to Nil. In some instances, however, numerical values may be received. These are of little use unless the type of measuring device is given and a means of converting from the numerical value to a descriptive term is available.

VALUE TABLE (Report Types)

DESCRIPTION	JAMES BRAKE	TAPLEY	SAAB	MUMETER
Good	15 - 26	43 - 100	60 - 100	51 - 80
Fair* to Good	---	---	---	---
Fair	11 - 14	35 - 42	36 - 59	36 - 50
Fair to Poor	---	---	---	---
Poor	8 - 10	21 - 34	21 - 35	26 - 35
Nil	4 - 7	0 - 20	0 - 20	10 - 25

NOTE: The value "MEDIUM", if issued, equates to "FAIR".

The following terms are suggested for use when referring to either of the foregoing scales, MuMeter or James Brake:

NORMAL - Maximum energy stops possible with little deterioration in certified stopping distance.

GOOD --- More braking is available than will be used in an average airline-type deceleration. If a maximum energy stop were attempted, some distance in excess of certified stopping distance would be expected.

FAIR --- Sufficient braking and cornering is available for a well flown approach and landing using light braking. However, excess speed or long touchdown would result in an extremely low safety factor depending on runway length and crosswind component. Careful planning and good judgment are required.

POOR --- Very careful planning, judgment, and execution are absolutely essential. Crosswind becomes a "priority one" consideration. While a safe and successful approach, landing, and stop can be accomplished if all factors are favorable, there is little room for error. Care must be exercised in every facet of the operation and a very careful evaluation of all existing conditions is necessary.

WET AND SLIPPERY RUNWAYS

DISPATCH POLICIES

Turbojets are restricted by the FAA to 1/2-inch slush or standing water for takeoff. However, USAir takes an even more conservative approach as evidenced by the 1/4-inch normal restriction.

Also, regulations require that a turbojet aircraft cannot takeoff when weather reports and forecasts indicate that the runway at the destination airport may be wet or slippery at ETA unless the wet/slippery 15% additional runway limitations from the Airport Analysis pages are applied. It should be noted that these are dispatch rules and do not apply when aircraft arrives at a destination airport to encounter unforecast wet/slippery runway conditions.

However, in each case, judgment must be based upon operating experience into those airports concerned and consideration of all factors. The Captain is bound by the requirement to operate the aircraft safely and use good judgment in the actual conditions encountered.

A flight may be dispatched on the basis of a dry runway when the following conditions are forecast for the destination airport and no other factors or conditions indicate that the landing runway may be wet or slippery at the ETA:

- Scattered showers in the area.
- Intermittent drizzle, no greater than moderate.
- Intermittent light rain (surface temperature above 32°F.)
- Light snow with surface temperature below 28°F.

Fluid drag effects on turbojet transport aircraft caused by the higher takeoff speeds have led to FAA guidelines in the so-called 1/2-inch rule: (Dispatch policy is 1/4-inch limit)

"Takeoffs should not be attempted when standing water, slush or wet snow greater than 1/2-inch in depth (Dispatch policy is 1/4-inch limit) covers an appreciable part of the runway".

AIRCRAFT CONFIGURATION

When operating in wet and slushy conditions, the BAC 1-11 is fitted with Chine B nosewheel which provides the best protection against the critical side spray. Proper tire inflation is recommended because underinflated tires will hydroplane at lower speeds, thus initiating side spray and wheel spin-down earlier in the takeoff run.

TAKEOFF

Water Ingestion

Turbojet engines can ingest a moderate amount of spray without affecting engine performance.

Ingestion of light spray is usually not displayed on the engine instrumentation in the cockpit nor does it appreciably affect engine performance. Large slugs of spray may distort the inlet airflow sufficiently to cause a compressor stall. The stall can be detected in the cockpit by a momentary drop in P-7/EPR or HP RPM drop. In the event of severe engine banging (an indication of compressor stalls), accompanied by prolonged and repeated P-7/EPR and HP RPM degradation, the takeoff should be aborted when below the V1 speed.

WET AND SLIPPERY RUNWAYS (cont'd.)

TAKEOFF (cont'd.)

Water Ingestion (cont'd.)

It should be noted that noise generated by spray or slush impinging on the underside of the fuselage aft of the nose gear can be mistaken for engine compressor stall noise. A compressor stall should not occur under normal operation of the airplane. If noise is not accompanied by P-7/EPR and HP RPM degradation, and aircraft acceleration is normal, the takeoff should be continued.

The Spey engines on the BAC 1-11 apparently can tolerate large quantities of water without damage or malfunction.

During takeoff from a wet runway, water will be thrown up by main and nose wheels. Some water from the nose wheels will pass over the wings and some of this will enter engine intakes. For this condition, use of igniters gives added protection against possible flameout. Water from the main wheels will not go near the engine air intakes, but a large proportion will strike wing flaps.

Ignition

Igniters must be switched ON for all takeoffs and landings on wet or slushy runways.

LANDING

The use of reverse thrust when the coefficient of friction between tires and runway surface has been reduced by runway conditions appears to have been a factor in a number of recent incidents involving aircraft going off the side of the runway. Under slick runway conditions, brakes may not be effective in preventing the airplane from veering to one side as a result of conditions such as asymmetrical reverse thrust application due to either a slow acting reverser, slow engine spool up, or thrust lever rigging. Certain combinations of reverse thrust, cross-wind and degree of runway crowning can also drive the aircraft off one side of the runway.

The use of asymmetrical thrust is of little help in maintaining directional control in the case of aft-mounted engines. A further consideration in aft-mounted engine configuration is the reduced rudder effectiveness during use of reverse thrust. The reduction in rudder effectiveness can be significant throughout a range of airspeeds and even when minimum reverse thrust is applied at the lower rollout speeds.

During landing roll, whenever drift across the runway develops or other directional control problems occur, corrective action to straighten the aircraft roll path would be to return thrust levers to minimum idle reverse or to forward idle thrust to reduce the thrust vector tending to drive the airplane to one side and then use differential braking and rudder. Once corrective action has been effective, symmetric reverse thrust could then be reapplied if needed.

WET AND SLIPPERY RUNWAYS (cont'd.)

LANDING (cont'd.)

When landings are made on runways with heavy accumulations of standing water or slush, operational techniques such as minimum safe touchdown speed, early runway contact, and early use of wheel brakes, spoilers, and reverse thrust should be employed to decrease the aircraft landing roll. Of course, reverse thrust and wheel brakes should be used with caution since asymmetrical thrust or drag on the aircraft for these slippery runway conditions may be difficult to control.

Under Federal Aviation Regulations, additional landing runway length is computed for wet or slippery runways on a dispatch basis.

Pilot should note that the 15% additional runway requirement for "wet" runways suffices for the 15% required when landing with visibility below 3/4 mile or 4000 RVR. Thirty percent (30%) additional is not required.

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Supplied by Jeppesen Sanderson

AIRCRAFT TIRE HYDROPLANING

GENERAL

When pneumatic tires of aircraft (or of highway vehicles as well) roll over water-covered or flooded pavements, hydro-dynamic pressure develops between the tire footprint and the pavement. The pressures grow larger as the ground speed increases. At a critical speed, hydrodynamic lift resulting from the built-up pressure under a tire will equal the weight riding on the tire. When this occurs, hydroplaning speed has been reached. Any increase in ground speed above this critical value lifts the tire completely off the pavement, leaving it supported by the fluid alone. The result is called total tire hydroplaning.

SURFACE

Research thus far indicates that total tire hydroplaning will not occur on most runways or roads until the paved surface is flooded or heavily puddled with water or slush. Most runways and roads are designed with a crown to drain water away readily. Such crowned pavements should not become flooded unless very heavy rain or deep slush accumulates.

A typical characteristic of tire planing is whitish marks left on the runway after the phenomenon has taken place. These marks are the result of a scrubbing or cleaning action provided by large suction forces under the tire when hydroplaning.

Tire hydroplaning research indicates that tires require less fluid depth to hydroplane on smooth surfaces than on rougher pavement. Also, bald or smooth tread tires tend to hydroplane in more shallow fluid depths than tires with ribbed or patterned treads.

SIGNIFICANCE OF TIRE PRESSURES

From data obtained from NASA hydroplaning tests, it was determined that a tire rolling from dry pavement to a flooded section would hydroplane at a speed equal to $9\sqrt{p}$. This relationship was corrected by later investigations to indicate that a tire would hydroplane as the airplane touched down at a speed as low as $7.7\sqrt{p}$, where p = tire pressure in pounds per square inch. (This equation is valid for smooth tires or for grooved tires where fluid depth exceeds tread groove depth.)

At ground speeds above the total hydroplaning speed, the tire lifts off the pavement surface and tire-ground friction forces drop to insignificant values because the fluid cannot develop large shear forces. In addition, hydrodynamic lift acting between the tire and ground tends to shift the vertical ground reaction on the tire in a way that produces a spin-down tendency on the tire. These two major effects combine to produce the following sequences of tire hydroplaning:

(1) Pneumatic tires on free rolling or unbraked aircraft or automobiles can spin-down to a complete stop at ground speeds near or above the total hydroplaning speed.

(2) Tires suffer nearly complete loss of braking traction and cornering capability. This loss can result in severe vehicle skidding under action of only small external side forces on the vehicle.

(3) Even at lower speeds in deep fluids, partial hydroplaning can occur, so that both tire-to-ground friction coefficients and cornering ability are reduced.

AIRCRAFT TIRE HYDROPLANING (cont'd.)

SIGNIFICANCE OF TIRE PRESSURES (cont'd)

Associated hazards of tire hydroplaning to aircraft operation are greatly increased stopping distances and potential loss of ground directional stability. Crosswinds during takeoff and landing operations on flooded runways may greatly increase the possibility of aircraft skidding.

TYPES OF HYDROPLANING

There are three types of hydroplaning:

(1) The first is **DYNAMIC** hydroplaning which occurs when there is standing water on the runway surface. Water about one-tenth of an inch deep acts to lift the tire off the runway as explained above.

(2) The second type is **VISCOUS** hydroplaning due to the viscous properties of water. In this type, a thin film of fluid not more than one-thousandth of an inch in depth cannot be penetrated by the tire and the tire rolls on top of the film. This can occur at a much lower speed than dynamic hydroplaning but requires a smooth acting surface.

(3) The third type, known as **REVERTED** rubber hydroplaning, requires a prolonged locked wheel skid, reverted rubber, and a wet runway surface. The reverted rubber acts as a seal between the tire and the runway and delays water exit from the tire footprint area. The water heats and is converted to steam and the steam supports the tire off the pavement.

WIND SHEAR

GENERAL

The most important elements for the flight crew in coping with a wind shear environment are crew awareness of an impending wind shear encounter and their decision to immediately respond and properly control the airplane when the actual encounter occurs. It is important that the basic factors involved in the wind shear phenomena, the effects wind shear has on the airplane, and the proper corrective pilot control actions are understood by the flight crew. The following information is offered to provide some general insights and specific procedures to best cope with low altitude wind shear.

DEFINITIONS

Wind shear can be divided into two general categories:

Increased Performance Wind Shear - An increase in headwind or decrease in tailwind which tends to cause an increase in indicated airspeed.

Decreased Performance Wind Shear - A decrease in headwind or increase in tailwind which tends to cause a decrease in indicated airspeed.

Increased performance shears tend to increase airspeed and decreased performance shears tend to decrease airspeed.

METEOROLOGICAL CONDITIONS CONDUCIVE TO SHEAR

Wind shear situations exist under a broad range of meteorological conditions and emphasis has been established by the FAA on wind shear pilot reports, forecasting, and measuring programs. Crewmembers should be knowledgeable of the meteorological conditions involved to the extent that basic related factors can be applied in a practical way. Strong temperature inversion, frontal activity and thunderstorms are those weather phenomena most closely associated with wind shear. Some examples are outlined below:

Strong Temperature Inversion - An air temperature change existing across the inversion which may indicate the presence of variable wind conditions.

Frontal Activity - The existence of low level wind shear can be inferred by the temperature difference immediately across the front and by the speed at which the front is moving. For instance, a frontal speed greater than 30 knots and/or a temperature difference equal to or greater than 10°F (6°C) are strong indicators of potential wind shear.

Thunderstorms - The convective air currents in and around thunderstorm cells are very complex and wind shear can be found on all sides of a cell. The shear boundary or gust front associated with thunderstorms can precede the actual storm by up to 15 nautical miles. Consequently, if a thunderstorm is near an airport of intended landing or takeoff, low level wind shear hazard may exist.

WIND SHEAR (cont'd.)

METEOROLOGICAL CONDITIONS CONDUCIVE TO SHEAR (cont'd.)

High Base Thunderstorms - Scattered to broken high-based cumulus or altocumulus clouds at 9,000 to 10,000 feet with very warm and dry surface conditions in combination with reports of scattered light rain or virga (falling precipitation that evaporates before reaching the ground) are precursors of an impending wind shear. When precipitation begins to fall into very dry surface conditions from high-based thunderstorms, a column of air much colder than the surrounding air is created as the falling moisture evaporates, thereby extracting heat from the air. This cold air rushes downward and may reach the ground as a gust front which is more typically associated with thunderstorm activity. However, gusty winds of this type will last for only a few minutes over a local area and may not reach an airport wind instrument. The rain or virga is usually visible and is reported in the remarks section of surface weather observations. High surface temperature with a large dew point spread (40°F/20°C) is another reported condition associated with this type of wind shear.

When any of these meteorological conditions exists, crew awareness of potential wind shear should be established and consideration should be given to the following procedures discussed for Approach/Landing and Takeoff.

APPROACH AND LANDING

General

The most important element for the flight crew during the approach and landing phase is for the pilot to recognize the wind shear when it occurs and immediately respond by application of power and control inputs. When a wind shear causes a large and sudden decrease in indicated airspeed, immediate increase in power and control airplane pitch attitude is critical to successful transition of the shear. The same immediate recognition and response is necessary for large magnitude downdrafts. A wind shear occurrence potential may be recognized by monitoring flight instruments during the approach.

With the airplane stabilized, a higher than normal pitch attitude, greater thrust setting and a decreased vertical speed indicates a headwind condition. A tailwind is characterized by a lower than normal pitch attitude, decreased thrust setting, and an increase in vertical speed. When ground speed is available, it can be compared with the true airspeed to provide the headwind or tailwind component acting on the airplane. A difference between this approach wind and the tower reported surface wind indicates a wind shear potential (remembering that the wind on the active runway may be different from the tower reported value). Flight instruments should be closely monitored, especially when the existence of a wind shear is indicated, to provide an immediate or timely indication of a wind shear occurrence.

Decreased Performance Wind Shear and Downdrafts

When ground speed is available, the ground speed should not be allowed to decrease to less than 10 knots below threshold speed.

NOTE: Generally, this 10 knot ground speed relationship to indicated airspeed is only applicable to sea level standard conditions. When landing on higher altitude airports, the 2 knots/1,000 feet pressure altitude effect on true airspeed changes this relationship. However, pilot procedure to never fly below V_{REF} will properly compensate for this effect.

WIND SHEAR
(cont'd.)

APPROACH AND LANDING (cont'd.)

Decreased Performance Wind Shear and Downdrafts (cont'd.)

This procedure will maintain an energy level on the airplane that will enable it to fly through the decreased performance wind shear (one that causes a decrease in indicated airspeed), if encountered.

In the absence of ground speed information, when decreased performance wind shear is computed or reported, the approach speed should be increased by one-half the wind shear value. When this shear is greater than 15 knots or when strong downdrafts are present, the alternate flap setting consistent with operational considerations of landing runway length and conditions should be used. Upon encountering a decreased performance shear and/or downdraft, thrust and pitch attitude should be immediately increased to maintain an acceptable airspeed and flight path. Power should be immediately advanced to maximum power (up to the throttle mechanical limits), if necessary, and a go-around should be initiated when this type of encounter occurs at low altitude. Stick shaker speeds should be known for the approach and go-around configuration, and airspeed should be traded down to the stick shaker speed, if necessary, to prevent ground impact.

Increased Performance Wind Shear

If an increased performance wind shear (one that causes an increase in indicated airspeed) is encountered during a manual throttle controlled ILS approach, do not make a large thrust reduction at low altitude. A reversal might occur that would require an immediate thrust increase. If the airplane speed becomes too high at low altitude as a result of the wind shear, the landing should not be attempted. Monitor airspeed trends and throttle position closely and do not make large thrust reductions. During an ILS approach, early recognition of departure from the glideslope can be a forewarning of an impending shear.

Updrafts will tend to cause the airplane to rise above the approach path. To maintain the correct flight path, angle of attack must be decreased, which in turn will cause an increase in speed. This situation is similar to an increased performance shear condition, therefore, the same cautions and corrective actions are required.

TAKEOFF

When a wind shear is unexpectedly encountered at low altitude during takeoff, there is little the pilot can do to counter the effects. It is, therefore, very important for pilots to be knowledgeable of the weather phenomena associated with wind shear so that the precautionary measures described below can effectively be taken. Takeoff should not be attempted when moderate to heavy thunderstorms are over or near the airport unless the takeoff and departure can be made on a runway that is clear of the storm area and its associated gust front. Consideration should be given to any one or all of the following: changing the takeoff runway, the departure route, or delaying the takeoff.

WIND SHEAR (cont'd.)

TAKEOFF

When the possibility of wind shear exists, the following takeoff precautions should be taken:

- Use the longest runway available, when practicable.
- Do not use reduced thrust procedures.
- Carefully monitor the indicated airspeed during the ground roll acceleration to detect early signs of wind shear.
- Use the normal rotation speed. Note that if downdraft or wind shear is encountered during rotation, higher than normal rotation attitudes may be necessary to lift off.
- After liftoff, use less than normal pitch attitude to accelerate to V2 + 25, providing there are no obstructions in the flight path. If downdrafts or decreased performance wind shear are encountered after liftoff, to avoid ground contact, power should be immediately advanced to maximum power (up to the throttle mechanical limits). Rotate the airplane to a higher pitch attitude until the descent has stopped. Be prepared to allow the airspeed to decrease to stick shaker speed if necessary to avoid hitting terrain. However, be sure the airplane pitch is not increased too rapidly or that the airspeed does not decrease below stick shaker speed to avoid a stall condition. With all engines operating, the airplane will have substantial rate of climb at stick shaker speed. Once an attitude/airspeed is established which will provide a safe climb angle, it should be maintained until the shear penetration is complete. Reducing pitch attitude in an attempt to increase airspeed in the shear will result in a large descent rate. If clearance to surrounding terrain exists, maintain speed margin because decreased performance wind shears can be expected after traversing downdrafts.

SUMMARY

Crew awareness of a potential wind shear and their ability to immediately respond with thrust increase and control of airplane pitch attitude when a wind shear occurs are the key elements in coping with wind shears.

Supplied by Jeppesen Sanderson

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AIRCRAFT GENERAL DESCRIPTION

GENERAL

The BAC 1-11 is a swept-wing, two-engine transport, powered by two Rolls-Royce Spey 511-14 bypass (turbo-fan) engines.

The most distinctive structural features of the airplane are the two aft-mounted engines and high "Tee" tail.

All areas of the fuselage are pressurized except the radome, wheel well areas, center section torque box, and the tail area aft of the rear pressure bulkhead.

Fore and aft cargo compartments (2) are pressurized, but do not receive any direct ventilating airflow.

Integral, hydraulically operated stairs are provided at the forward and aft passenger loading doors.

The primary wing structure is a three-spar box. Fuel is carried in tanks built integrally into the wings and into the center wing box beam area.

All of the flight controls are normally hydraulically powered with the exception of the aileron system which is aerodynamically operated by a conventional control tab.

An auxiliary power unit (APU), located in a specially designed fireproof nacelle in the tailcone of the airplane, provides a source of air and electrical power both on the ground and in flight.

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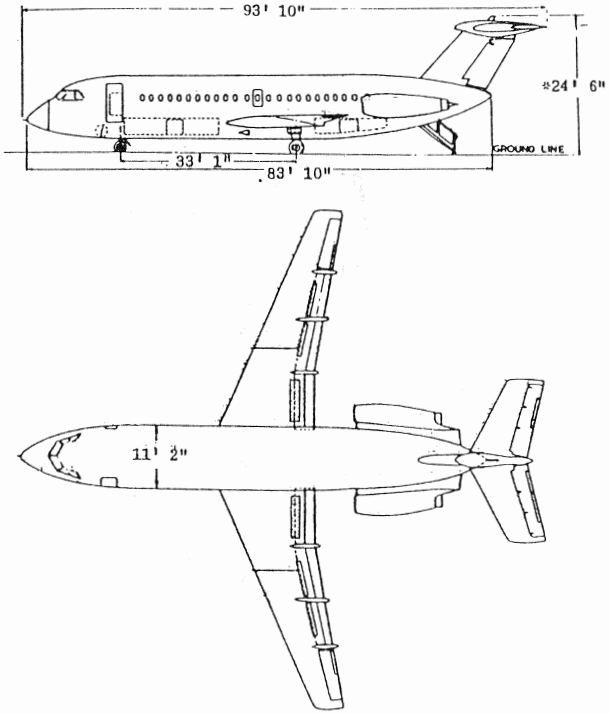
AIRCRAFT GENERAL DESCRIPTION

AIRPLANE DIMENSIONS

NOTE: Ground line is approximate for fully-loaded aircraft at Mid "CG" range.

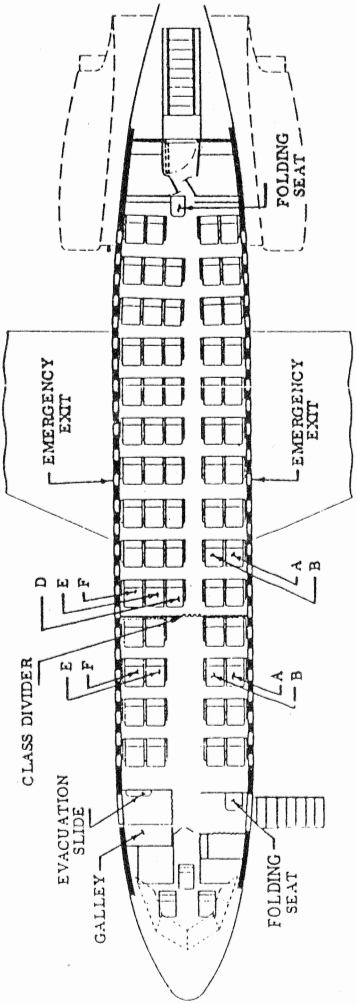


*Various ground clearance dimensions shown are approximate.

AIRCRAFT GENERAL DESCRIPTION

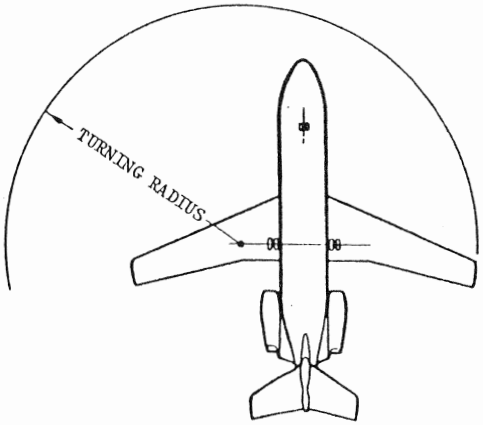
INTERIOR ARRANGEMENT

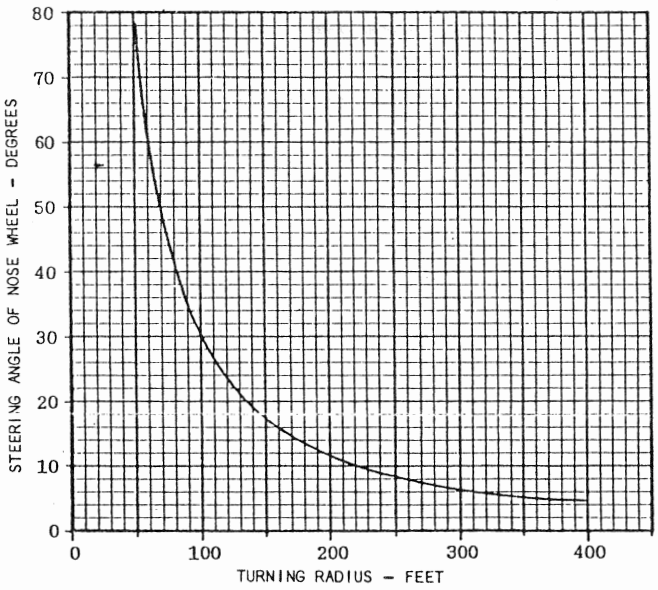
NOTE: Seating arrangement shown is typical and subject to change.



AIRCRAFT GENERAL DESCRIPTION

TAXI TURNING RADIUS





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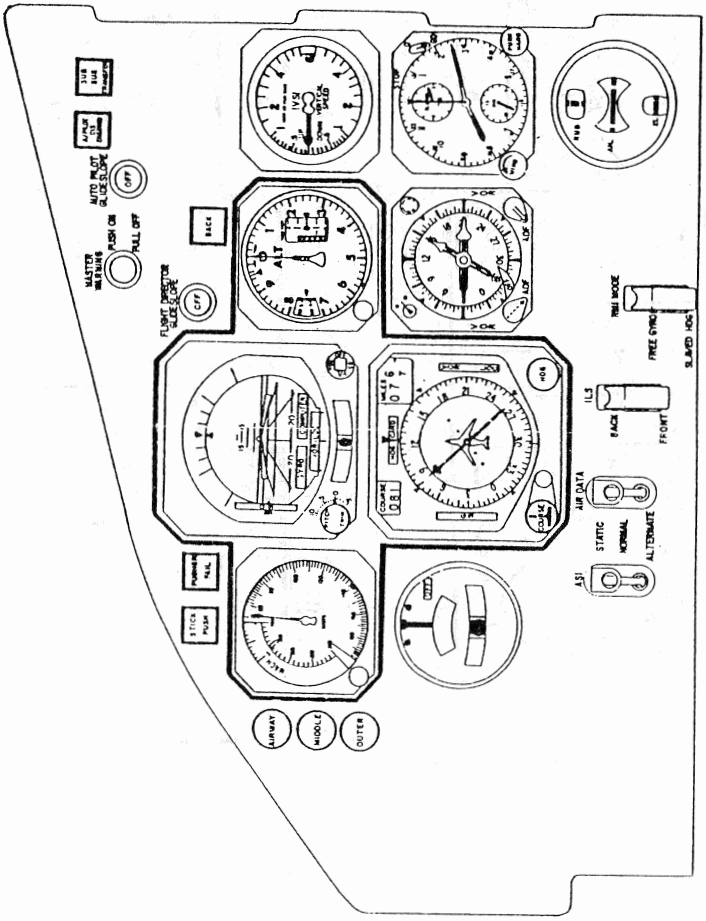
AIRCRAFT GENERAL DESCRIPTION

CAPTAIN'S INSTRUMENT PANEL



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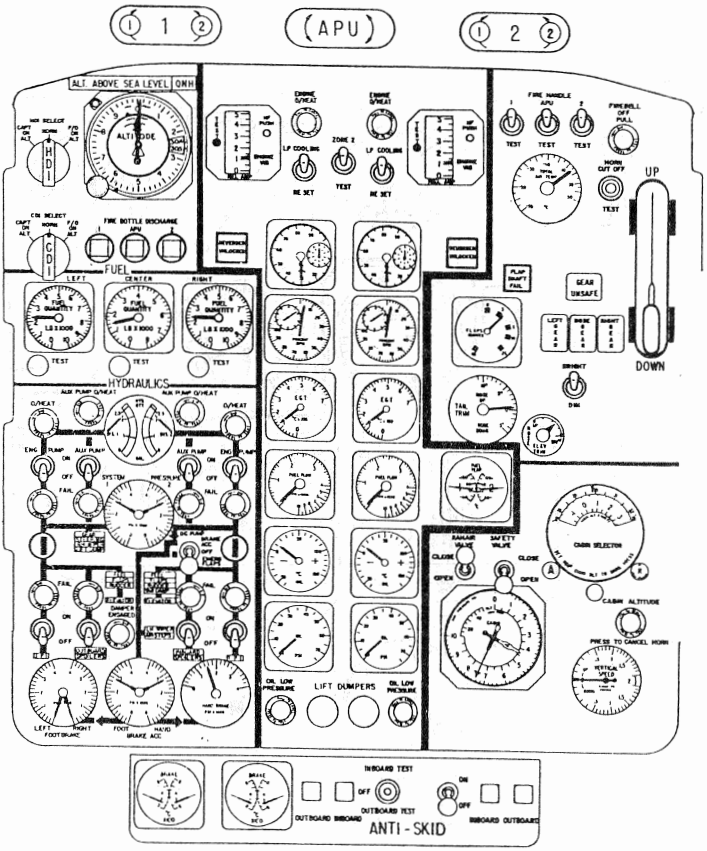
CENTER INSTRUMENT PANEL



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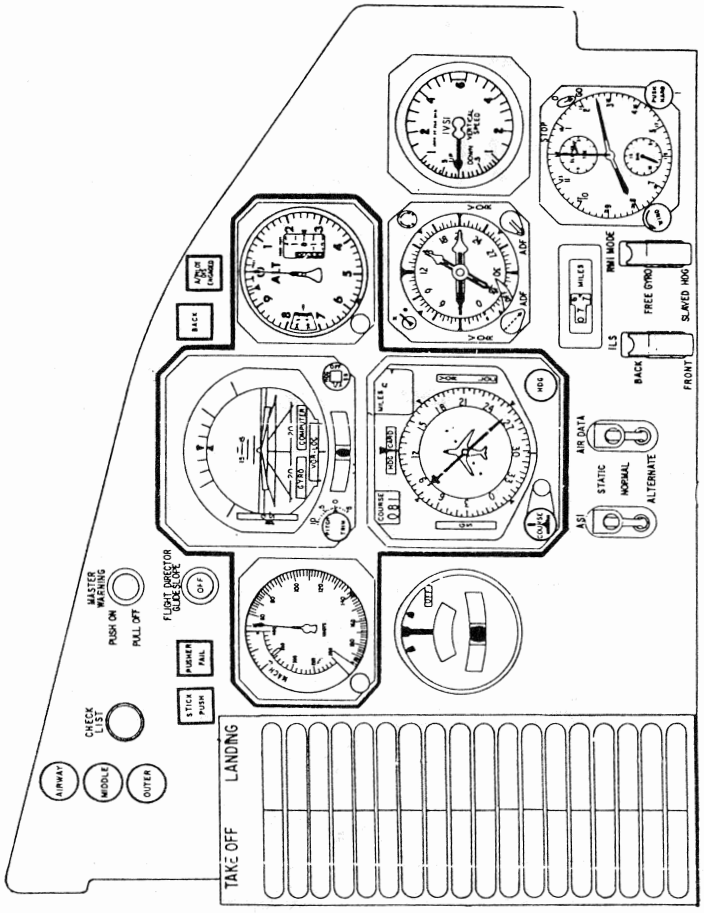
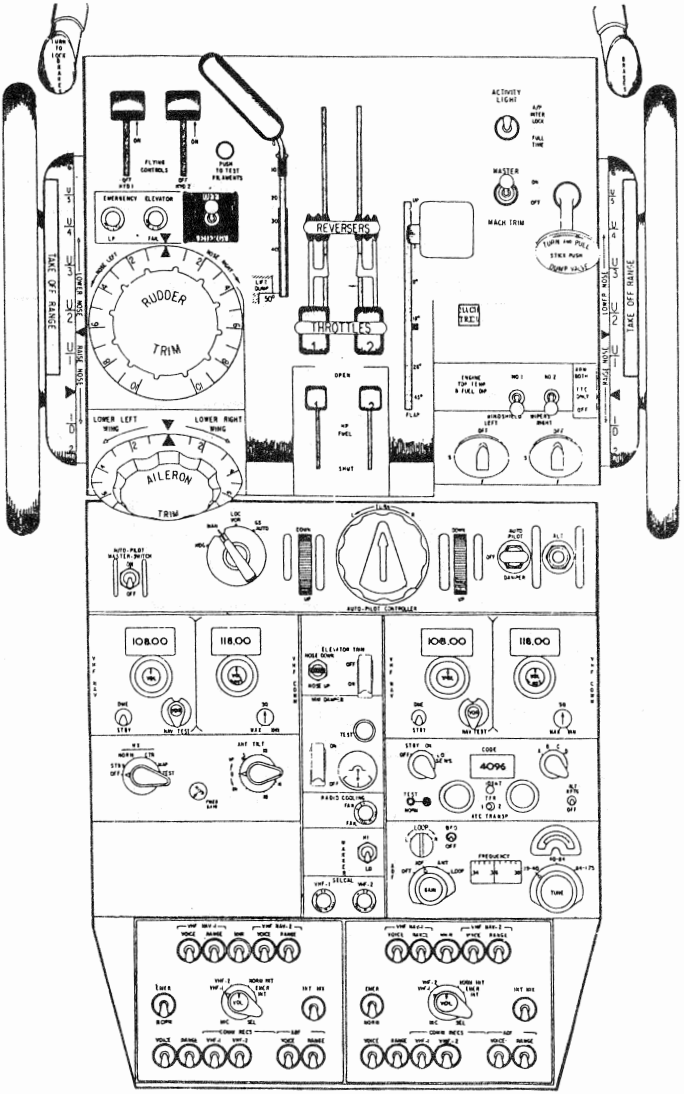
FIRST OFFICER'S INSTRUMENT PANEL



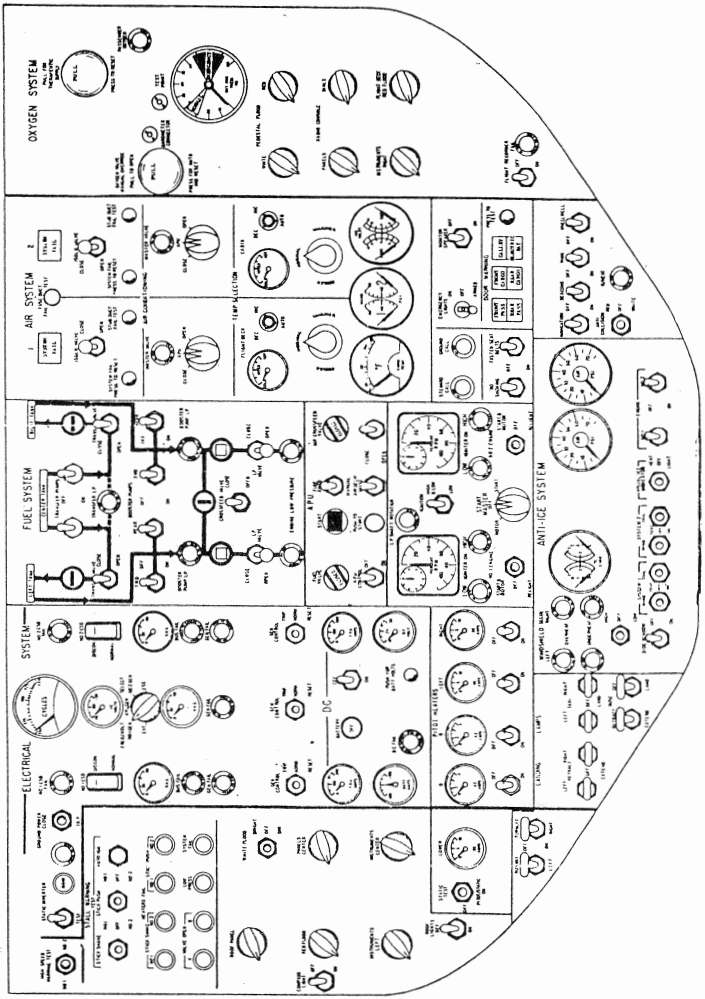
AIRCRAFT GENERAL DESCRIPTION

PEDESTAL



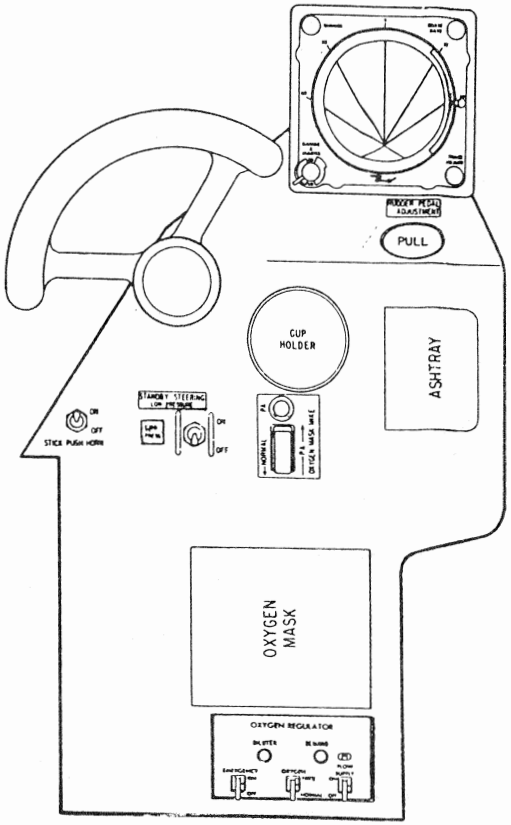
AIRCRAFT GENERAL DESCRIPTION

OVERHEAD INSTRUMENT PANEL



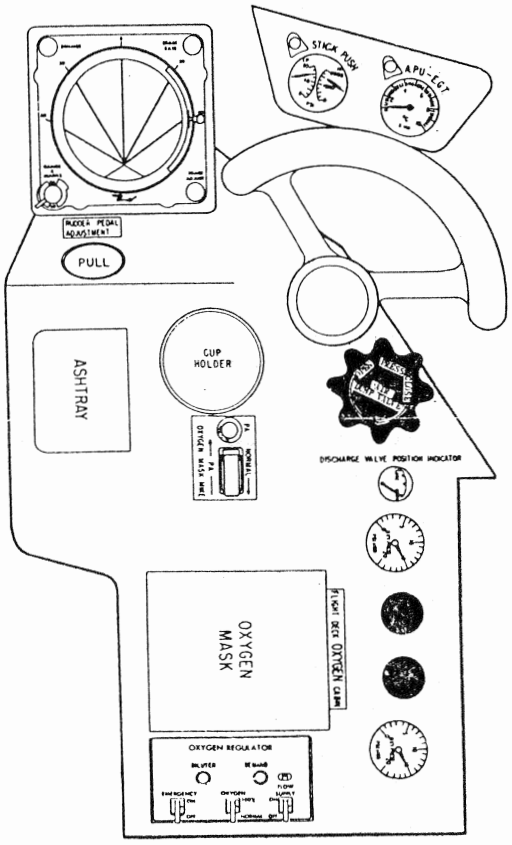
AIRCRAFT GENERAL DESCRIPTION

CAPTAIN'S CONSOLE



AIRCRAFT GENERAL DESCRIPTION

FIRST OFFICER'S CONSOLE



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AIRCRAFT GENERAL DESCRIPTION

INTERIOR LIGHTING

Cockpit Lighting

General

Cockpit lighting provides general illumination of the cockpit and local illumination of the panels, instruments, and controls. Local lighting for specific areas is provided by chart, map table, right side console circuit breaker panel and compass lights.

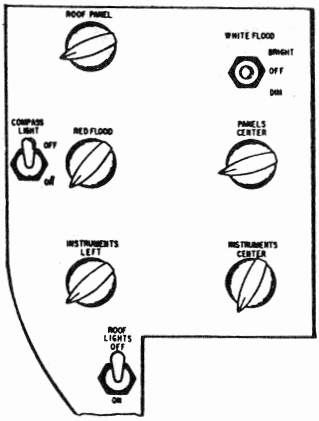
Captain's Overhead Lighting

The Captain's overhead light control panel utilizes variable intensity knobs to control:

- ROOF PANEL (overhead panel lighting).
- RED FLOOD (white flood lights under glareshield). Must be on for night takeoff.
- PANELS CENTER (integrally lighted panels on center instrument panel).
- INSTRUMENTS LEFT (Captain's integrally lighted instruments and panels).
- INSTRUMENTS CENTER (integrally lighted instruments on center instrument panel).

In addition, toggle switch control is available for:

- COMPASS LIGHT (OFF/ON).
- WHITE FLOOD (BRIGHT/OFF/DIM) (under glareshield).
- ROOF LIGHTS (OFF/ON) (General white illumination of cockpit from flight deck roof assembly).



(cont'd.)

AIRCRAFT GENERAL DESCRIPTION

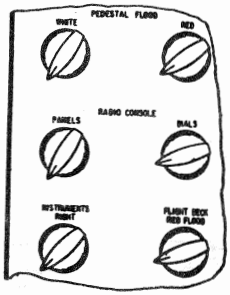
INTERIOR LIGHTING (cont'd.)

Cockpit Lighting (cont'd.)

First Officer's Overhead Lighting

The First Officer's overhead light control panel utilizes variable intensity knobs to control:

- PEDESTAL FLOOD - RED (red flood light located in flight deck roof).
- PEDESTAL FLOOD - WHITE (white flood light locatd in flight deck roof).
- RADIO CONSOLE - PANELS (integrally lighted pedestal panels).
- RADIO CONSOLE - DIALS (integrally lighted pedestal dials).
- INSTRUMENTS RIGHT (First Officer's integrally lighted instruments and panels).
- FLIGHT DECK RED FLOOD (red flood lights in flight deck roof for general illumination of cockpit).



Local Lighting

Chart Lights

These lights, one above each pilot's station, are controlled by a variable intensity knob marked CHART LIGHT next to each light. Rotation of the lower housing provides red or white lighting, while rotation of the upper housing adjusts the area of illumination.

Map Table Lights

Each pilot's map table is illuminated by a white light. Each is controlled by a variable intensity knob adjacent to the light.

Jump Seat Lighting

The controls for jump set lighting (chart and side panel) are located on the jump seat ICS panel.

(cont'd.)

AIRCRAFT GENERAL DESCRIPTION

INTERIOR LIGHTING (cont'd.)

Cabin Lighting

The cabin is equipped with a lighting system which provides indirect fluorescent lighting for normal use, incandescent blue lighting for dim and night time use, and white incandescent lighting for emergency use.

Eight roof lighting assemblies, located along the center line for the aircraft cabin, contain two fluorescent and two blue incandescent lights. Four lighting assemblies arranged in a square are contained in the aft fuselage between the lavatories. All of the aft fuselage assemblies contain two fluorescent bulbs. However, only the forward two assemblies contain blue incandescent bulbs for dim operation. The left aft assembly also contains a white bulb for emergency lighting. Cabin lighting, except for emergency lighting, is controlled from the forward flight attendant panel.

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AIRCRAFT GENERAL DESCRIPTION

EMERGENCY LIGHTING

Emergency lighting is provided throughout the aircraft to provide adequate illumination if power supplies to the normal lighting circuit fails. The installation consists of two systems:

- System No. 1 is powered by independent batteries within the emergency lighting units. When fully charged, the self-contained batteries will illuminate the individual light for about 15 minutes.

- System No. 2 receives power from the 28 volt DC ESS bus.

Opening the DC split circuit breaker automatically turns on System No. 1 and No. 2. Failure of all DC power supplies turns on System No. 1 only. If emergency lights illuminate due to opening of DC split circuit breaker, and no emergency exists, they should be turned OFF. If the emergency lights are turned OFF to conserve their self-contained batteries, it should be remembered that ESS DC power is required to turn the emergency exit lights back ON again.

System No. 1 consists of four fixed emergency lamp assemblies equally spaced along the cabin roof. Six portable assemblies are located as follows:

- Cockpit Roof
- Forward Entrance Door
- Galley Door
- Overwing Left
- Overwing Right
- Above Rear Pressure Bulkhead

System No. 2 consists of fourteen (14) "peanut" bulbs located at the following positions:

- Forward Entrance Door (1)
- Galley Door (1)
- Each Centerline Cabin Light Assembly (8)
- Each Lavatory (2)
- Rear Entrance Door (1)
- Rear Stairwell (1)

The bulbs in System No. 2 and the charging current for System No. 1 self-contained batteries are powered by the 28-volt DC ESS bus.

Primary control of these systems is through the emergency lights OFF/ARMED/ON toggle switch.

NOTE: On some aircraft, the emergency lights switch operating sequence is ARMED/OFF/ON. Due to relays within the circuit, the emergency lights on these aircraft may fail to illuminate if the switch is moved rapidly from the ARMED to the ON position.

On engine shut down, should the emergency lights be inadvertently left ON, the battery switch must be positioned to ON prior to turning the emergency lights switch to OFF.

(cont'd.)

AIRCRAFT GENERAL DESCRIPTION

EMERGENCY LIGHTING (cont'd.)

A second Cabin Emergency Exit light switch is located on the outboard side of the forward H_2O extinguisher, directly opposite of the flight attendant seat. This two-position (NORMAL/ON) lever lock switch will light the emergency exit lights when placed to ON. In the NORMAL position, the emergency exit lights are controlled from the cockpit overhead panel. The flight attendant will place this switch to ON when an evacuation is initiated.

The door and fuselage mounted evacuation lights, if installed, are powered by self-contained batteries.

- The door mounted lights will illuminate when the evacuation slides are deployed and will illuminate the area at the base of the slide.

- The fuselage lights will illuminate the ground area at the wing trailing edge when the overwing exits are opened.

These lights are prefocused and tested by Maintenance.

FLIGHT CONTROLS SYSTEM DESCRIPTION

MASTER WARNING SYSTEM

Two master warning lights, one on each pilot's instrument panel, give an immediate indication of certain system failures. Each light incorporates a PUSH ON/PULL OFF type switch and indicates by flashing when a system failure light is illuminated. The system fail lights included in the master warning system are:

- No. 1 or No. 2 bus fail
- DC fail (bus)
- Left or right booster pump low pressure
- No. 1 or No. 2 engine overheat
- No. 1 or No. 2 oil low pressure
- No. 1 or No. 2 flying controls
- Emergency elevator fail

To prevent nuisance flashing of the master warning lights, the circuits for the No. 1 or No. 2 bus fail and the left or right booster pump low pressure have built-in time delays.

Whenever one or more of the system failure lights is illuminated, the master warning lights also illuminate. The master warning lights flash alternately until:

- The failure condition is corrected, or
- The system failure lamp is cancelled, or
- The master warning lamp is cancelled.

If only one master warning light is cancelled, light remains on steady, the other master warning light will continue to flash. If the affected system failure light is cancelled, the master warning system will be reset.

All system failure lights are the PULL-TO-CANCEL type, except the No. 1 or No. 2 flying controls and the emergency elevator fail. These lights must be cancelled by deactivating the affected system.

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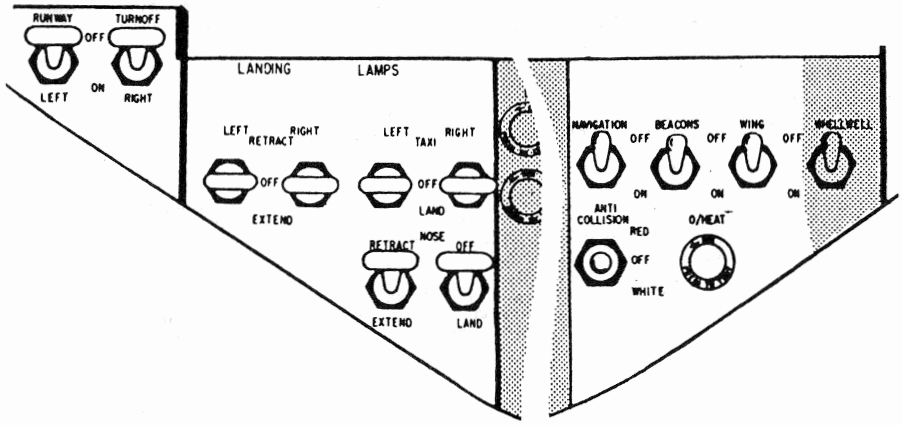
AIRCRAFT GENERAL DESCRIPTION

EXTERIOR LIGHTING

Exterior lighting consists of Runway Turn Off, Landing and Taxi, Ice Inspection (wing), Navigation, Beacon, and Anti-Collision lights.



Runway Turn Off Lights

These lights are located in the leading edge of each wing root and are individually controlled.

Landing/Taxi Lights

These retractable assemblies are located in each wing leading edge and in the lower nose section.

Ice Inspection Lights

Two recessed lights, in the forward fuselage, illuminate the leading edge of the wings. Two lights, in the wing fillet at the trailing edge, illuminate each engine air intake. All four lights are controlled by a WING (OFF/ON) toggle switch.

NOTE: The wing lights on some aircraft are equipped with "prismatic" lenses which cause the light beam to illuminate the inboard section of the leading edge and on other aircraft, the lights illuminate the outboard section of the wing.

(cont'd.)

AIRCRAFT GENERAL DESCRIPTION

EXTERIOR LIGHTING (cont'd.)

Navigation Lights

Conventional red and green lights are installed in the respective left and right wing tips. A dual white tail light assembly is installed in the aft stabilizer bullet. A switch located on the aft flight attendant panel, placarded DUAL TAIL (UPPER/LOWER) allows selection of either lamp should one fail. All three lights are controlled by a single switch labeled NAVIGATION (ON/OFF).

Rotating Beacons

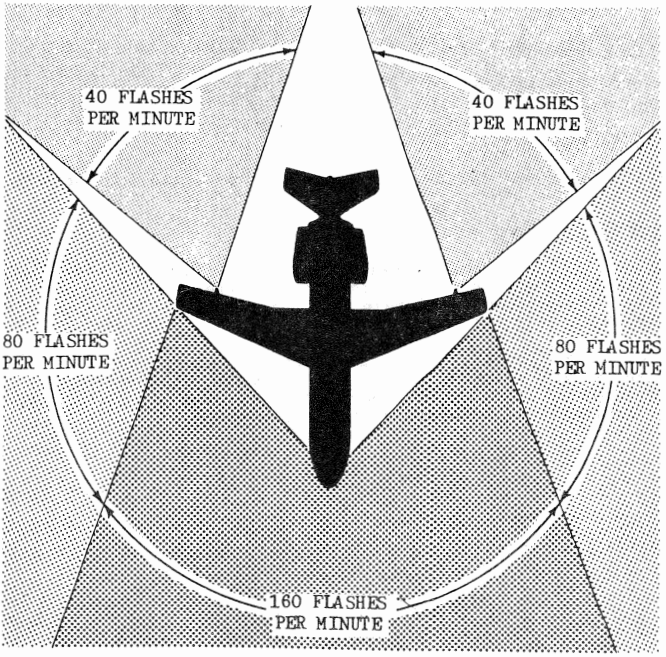
Two rotating beacons on the upper and lower fuselage are controlled by one toggle switch, placarded BEACONS (OFF/ON).

High Intensity Lights

Six light assemblies, 2 in each wing tip and 1 in each outboard bullet on the trailing edge of the wing, contain a Xenon tube that produces a red or white flash of about one-thousandth of a second in duration. These lights are visible at distances up to 35 miles at night.

All six lights are controlled through an ANTI-COLLISION (RED/OFF/WHITE) toggle switch. An amber O/HEAT light, adjacent to the switch, will illuminate if the control box overheats; in which case, the system should be turned OFF.

The lights are positioned so that the flash rate will permit determining the angle from which the aircraft is being viewed as illustrated below.



AIRCRAFT GENERAL DESCRIPTION

WATER SYSTEM

Cold Weather Drain Procedure

1. Pull Lavatory Water Heaters C/B #73 on Panel B-1.
2. Drain water tank (Water Service Panel):
   - Remove cap from tank drain fitting.
   - Stand clear and select drain valve to OPEN position.
3. Position water valve, located aft of radio rack, to SYS/FILT drain position.
4. Drain forward lavatory and water heater:
   - Locate drain valve under sink cabinet.
   - Open drain valve and leave open.
5. Drain aft lavatory and water heaters.
   - Locate drain valve in outside toilet service panel. Valve is located on aft bottom side of service panel.
   - Open the drain valve. Water will drain out of the hole located approximately 3 feet aft of toilet service panel.
   - Leave valve(s) open.
6. Hold both lavatory sink valves open for a sufficient amount of time to assure complete draining of lines and heaters for both lavatories.
7. To drain coffee maker, hold galley hot and cold water valve buttons in.
8. To drain bar sink, locate drain valve under bar sink cabinet and open lever-type drain valve.
9. After system is fully drained, close up system by accomplishing the reverse of Steps 2 through 8 above.
10. To restore water system for use:
    - Fill tank.
    - Turn A/C air ON.
    - Purge system of air by opening lavatory and galley outlets until water flow is steady.

      NOTE: System can be purged faster by closing the MAC valves to get higher duct pressure.

    - Reset C/B #73 on Panel B-1.

(cont'd.)

AIRCRAFT GENERAL DESCRIPTION

WATER SYSTEM (cont'd.)

To Drain System and Leave Water in Tank

1. At water service panel, remove cap from overflow outlet and pull filler valve handle to OPEN position. This will release air pressure from tank.
2. Pull Lavatory Water Heaters C/B #73 on Panel B-1.
3. Position water valve, located aft of radio rack, to SYS/FILT drain position.
4. Drain forward lavatory and water heater:
   - Locate drain valve under sink cabinet.
   - Open drain valve and leave open.
5. Drain aft lavatory and water heaters.
   - Locate drain valve in outside toilet service panel. Valve is located on aft bottom side of service panel.
   - Open the drain valve. Water will drain out of the hole located approximately 3 feet aft of toilet service panel.
   - Leave valve(s) open.
6. Hold both lavatory sink valves open for a sufficient amount of time to assure complete draining of lines and heaters for both lavatories.
7. To drain coffee maker, hold galley hot and cold water valve buttons in.
8. To drain bar sink, locate drain valve under bar sink cabinet and open lever-type drain valve.
9. After system is fully drained, close up system by accomplishing the reverse of Steps 3 through 8 above.
10. Shut down aircraft air system.
11. Restow filler valve handle and cap outlet at Water Service Panel.

    NOTE: Do not turn aircraft air system on again so tank will stay depressurized.

12. To restore water system for use:
    - Turn aircraft air system on.
    - Purge system of air by opening lavatory and galley outlets until water flow is steady.

      NOTE: System can be purged faster by closing the MAC valves to get higher duct pressure.

    - Reset C/B #73 on Panel B-1.

(cont'd.)

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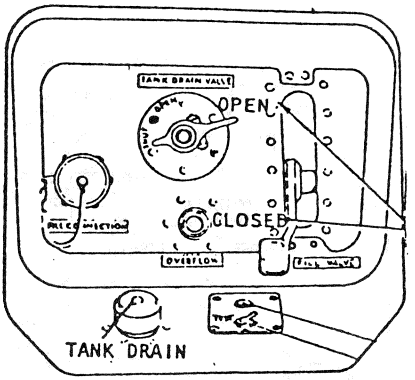
AIRCRAFT GENERAL DESCRIPTION

WATER SYSTEM
(cont'd.)

Domestic Water Service Panel



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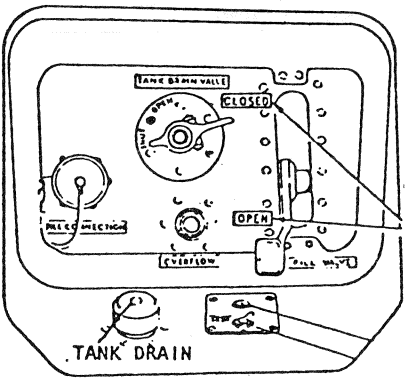

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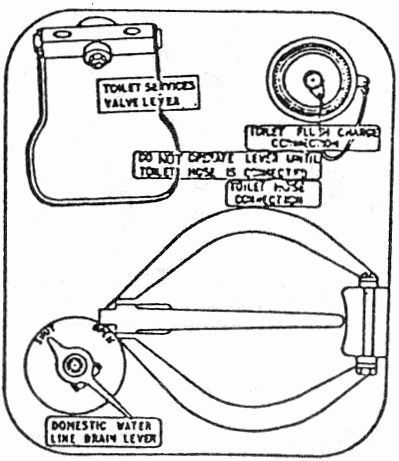
AIRCRAFT GENERAL DESCRIPTION

WATER SYSTEM
(cont'd.)

Toilet Service Panel (Right Side)



AIRCRAFT GENERAL DESCRIPTION

COFFEE MAKERS

The following description is a guide which is not intended for flight crew use in flight, but only for operation on-the-ground, if Maintenance is not available:

Coffee Maker Inoperative

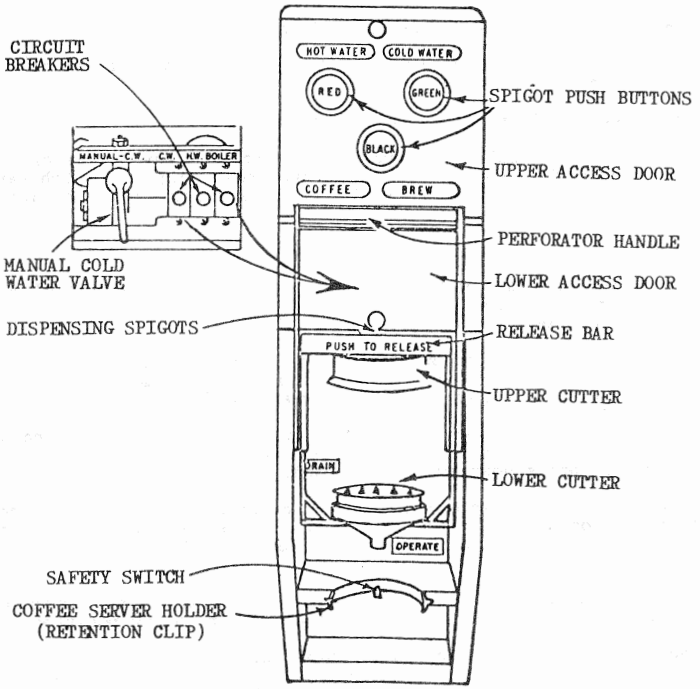
1. Check coffee maker fuses on Buffet Switch Panel.
2. Open lower front face access door of the coffee unit.
3. Turn MANUAL CW valve ON (horizontal) until a steady stream of water flows, then turn OFF (vertical).
4. Depress CW (cold water) circuit breaker.
5. Depress and hold cold water pushbutton until steady stream of water flows from right hand spigot. Hold cup under spigot to catch water. If cooler tank is empty, it will require approximately 3 minutes to fill.
6. Depress HW (hot water) circuit breaker.
7. Depress and hold hot water pushbutton until steady stream of water flows from left hand spigot. If boiler tank is empty, it will require approximately 3 minutes to fill.
8. Depress Boiler circuit breaker, which starts heating cycle. When boiler is heated to required temperature, approximately 5 minutes, BREW sign will illuminate. Unit is ready to make coffee.
9. Position the perforator so that the coffee can may be inserted into the mechanism. Depress the release bar, if installed, and pull perforator handle down with other hand.
10. Shake coffee can to loosen the packed grounds. Insert coffee can in lower portion of perforator on top of cutters and vigorously push up on handle. Perforator handle must lock in UP position to punch holes in top and bottom of can.
11. Insert Coffee Server snugly into retention clip. The server does not fit in the machine unless the handle is in the UP position.
12. Check to be sure BREW sign is illuminated.
13. Depress coffee button to start coffee cycle.
14. If the coffee cycle is interrupted for any reason, no adjustment is necessary. The unit will automatically reset itself for a new cycle. However, remove can from perforator and empty server; then, start cycle over at Step 10.
15. It will take approximately 3 minutes for a complete cycle, during which time there will be a steady stream of coffee dispensed.
16. Enter any discrepancies in the aircraft log book.

(cont'd.)

AIRCRAFT GENERAL DESCRIPTION

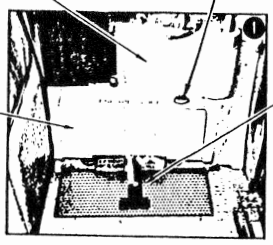
COFFEE MAKER
(cont'd.)

Controls & Indicators



AIRCRAFT GENERAL DESCRIPTION

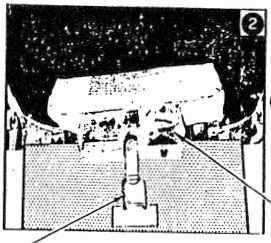
INFLATABLE EVACUATION SLIDE OPERATION



Operation of door mounted evacuation slides is as follows:

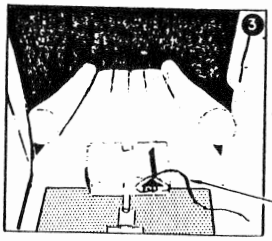
❶ Attach hook to floor attach point.

Note: Forward passenger door shown. Window and lanyard will be on opposite side of container on galley door.



❷ Open door. Slide will be pulled from container.

Lanyard



❸ Pull lanyard to inflate slide.

Lanyard

NOTE:
Retaining hook of all door-mounted escape slides must be attached to the floor attach point during taxi, take-off and landing whenever passengers are carried.

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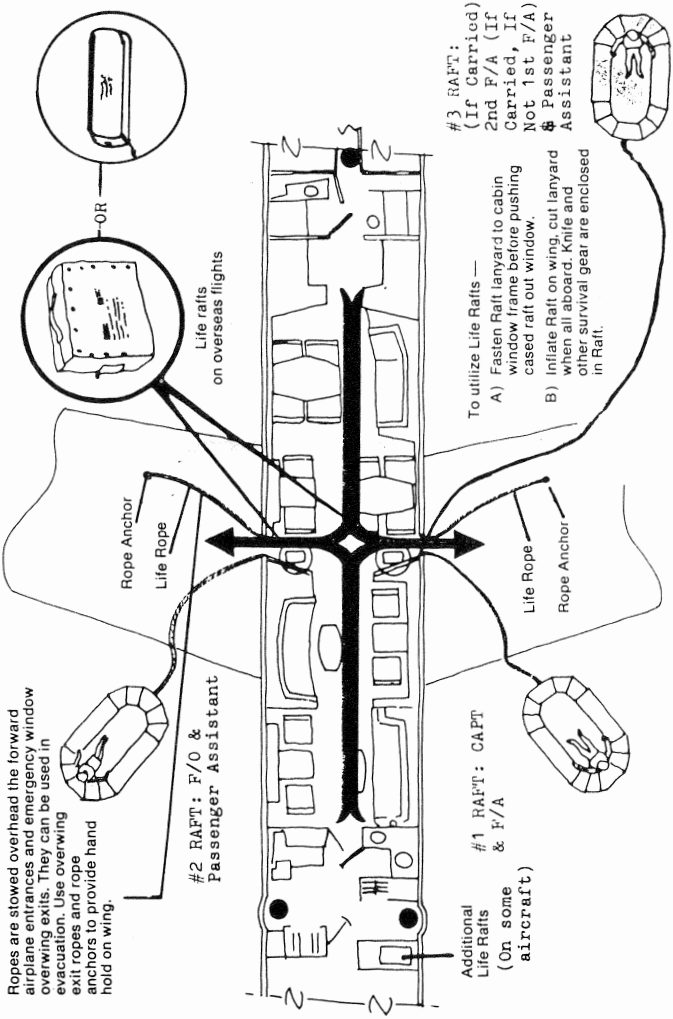
AIRCRAFT GENERAL DESCRIPTION

LIFE RAFTS


IN THE EVENT OF AN EMERGENCY, PASSENGERS CAN EXIT THROUGH THE OVER-WING CABIN WINDOW EMERGENCY EXITS. OPENING INSTRUCTIONS ON WINDOW AREA.
● FORWARD AND REAR AIRPLANE ENTRANCE DOORS CAN BE USED FOR EMERGENCY EXIT IF OPENED BY A CREW MEMBER.
Ropes are stowed overhead the forward airplane entrances and emergency window overwing exits. They can be used in evacuation. Use overwing exit ropes and rope anchors to provide hand hold on wing.
Rope Anchor
Life Rope
#2 RAFT: F/O & Passenger Assistant
-OR-
Life rafts on overseas flights
Additional Life Rafts (On some aircraft)
#1 RAFT: CAPT & F/A
To utilize Life Rafts —
A) Fasten Raft lanyard to cabin window frame before pushing cased raft out window.
B) Inflate Raft on wing, cut lanyard when all aboard. Knife and other survival gear are enclosed in Raft.
#3 RAFT: (If Carried) 2nd F/A (If Carried, If Not 1st F/A) & Passenger Assistant
Life Rope
Rope Anchor

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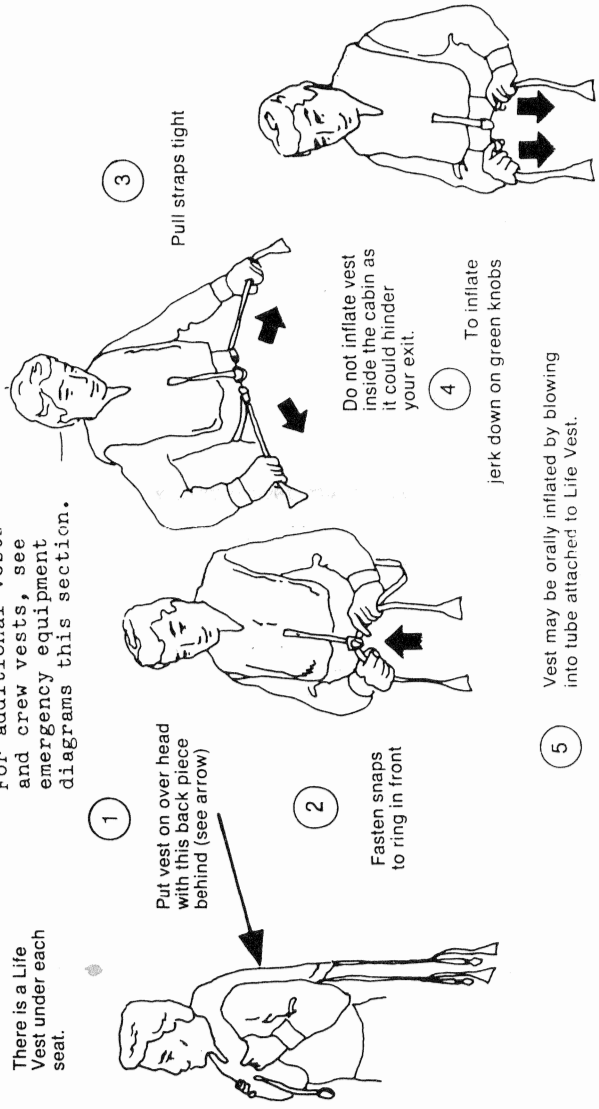
AIRCRAFT GENERAL DESCRIPTION

LIFE VESTS


There is a Life Vest under each seat.
For additional vests and crew vests, see emergency equipment diagrams this section.
1
Put vest on over head with this back piece behind (see arrow)
2
Fasten snaps to ring in front
3
Pull straps tight
Do not inflate vest inside the cabin as it could hinder your exit.
4
To inflate jerk down on green knobs
5
Vest may be orally inflated by blowing into tube attached to Life Vest.

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ICE & RAIN PROTECTION SYSTEM DESCRIPTION

GENERAL DESCRIPTION

In addition to the information contained in this chapter, it is recommended that the "COLD WEATHER OPERATIONS" information in Chapter 3A - ADVERSE WEATHER of this manual be reviewed.

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ICE & RAIN PROTECTION SYSTEM DESCRIPTION

"HOT ROD" ICE DETECTOR

General Description

A visual ice detector, called a "hot rod", is provided to give an indication of the existence of icing conditions. The detector is nothing more than a probe that projects out from the fuselage just below the Captain's sliding window. Ice accumulation on the probe is visible from the cockpit.

The probe contains an electric heater that permits melting ice off the probe peridically to determine icing rate. A light is installed at the base of the probe to illuminate it when desired.

Controls & Indicators

Both the heater and the light are controlled by a single switch on the cockpit overhead panel.

- The switch is spring-loaded to center (OFF) from the HEAT position.
- When the switch is held in the HEAT position, both the light and probe heater are operative.
- When the switch is selected to the LIGHT position, the light at the base of the detector will illuminate.

Operation

Move switch to LIGHT when required to illuminate rod for visual check.

Move switch to HEAT to deice the rod. The light also illuminates in this position.

Ice accretion on the rod should be shed periodically to determine if icing conditions still exist. If anti-icing systems have been activated, but no ice accretion can be seen on the hot rod, the anti-icing system can be turned OFF. However, the hot rod should be monitored at frequent intervals.

Prolonged operations with the ice detector switch in the LIGHT position will shorten lamp life, especially during ground operations. Assure switch is only positioned to LIGHT when the light is needed to monitor or check ice accumulation and that it is not inadvertently left in the LIGHT position.

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ICE & RAIN PROTECTION SYSTEM DESCRIPTION

ENGINE ANTI-ICING

General Description

Each engine inlet section (guide vanes and nose dome) and engine nose cowl can be heated with air extracted from the 17th stage of its compressor. The air is extracted from the 17th stage air manifold in such a way that it is available whether the bleed air isolation valve for that engine is open or closed.

The anti-icing air for each engine is supplied through two electrically operated, pneumatically controlled valves. The valves automatically limit the maximum pressure in the anti-icing supply line to about 50 PSI. Failure of one of the two valves in the closed position has little effect on the engine anti-icing capability.

Controls & Indicators

Engine Anti-Ice Switches (2)

These two-position (ON/OFF) switches are located on the overhead panel and control both anti-icing valves on the respective engine.

Engine Anti-Ice Pressure Gauges

These gauges, located above the engine anti-icing switches, indicate the pressure being supplied to the respective engine inlet through the anti-icing control valves.

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ICE & RAIN PROTECTION SYSTEM DESCRIPTION

WING & TAIL ANTI-ICING

General Description

Anti-icing protection is provided for the leading edges of the wings, horizontal stabilizer and vertical fin, and the "bullet" at the top of the vertical fin.

Hot air to the tail area is supplied through two electrically controlled, pneumatically operated valves from the left (No. 1) and right (No. 2) main pneumatic ducts. A restrictor, downstream from each control valve, automatically limits the airflow to the tail. The air used for tail anti-icing is exhausted overboard through openings on the underside of each horizontal stabilizer and on both sides of the vertical fin.

Hot air for wing anti-icing is also supplied through two electrically controlled, pneumatically operated valves from the left and right pneumatic ducts. The air is manifolded such that either valve will supply both wings. The air used for wing anti-icing is exhausted overboard through a series of small holes along the underside of the wing leading edge.

Controls & Indicators

Wing and Tail Anti-Ice Switches (4)

These switches, with ON-OFF-TEST positions, are located on the overhead panel. Each switch controls its respective anti-icing valve. The ON position is wired through the Main Landing Gear (MLG) "squat switch" circuitry. It will open its respective valve whenever the MLG struts are extended (airborne). If a wing or tail anti-ice switch is inadvertently left ON for landing, its respective valve will automatically close when main landing gear contact the ground. The momentary TEST position will open its respective valve, regardless of MLG strut position. The switch returns to OFF when released to avoid inadvertently leaving the switch ON following a test.

Wing and Tail Anti-Ice Temperature Indicator

This dual gauge indicates the temperature in the respective system downstream of both control valves, at the point where flow from the two pneumatic systems come together.

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ICE & RAIN PROTECTION SYSTEM DESCRIPTION

NORMAL OPERATION OF ANTI-ICING SYSTEMS (ENGINE, WING, & TAIL)

Before Takeoff

CAUTION: All ice, snow, and frost must be removed from flight surfaces prior to takeoff. All flight control balance panels must also be checked for ice, snow, or frost and any accumulation in these areas must be removed. Frost on the underside of the wing, due to cold soaking of the fuel, need not be removed.

Whenever it is known that engine and/or airframe anti-icing may be required for flight, systems should be checked after starting engines.

Check engine anti-icing by placing switches to ON and observing pressure rise. Normally, the engine anti-ice is checked on the daily originating flight, once during taxi-out and once during descent.

Check airframe anti-icing by holding switches to TEST and observing temperature rise. This position can also be used to preheat the surfaces before takeoff, if desired.

When the wing or tail anti-icing system is tested on-the-ground or wings are preheated, observe the following time limitations:

- ON ENGINE BLEED:

  At Idle Power:

  30 seconds maximum at ambient temperature above 10°C (50°F); no time limit below 10°C (50°F).

  At Higher Power Settings:

  30 seconds maximum, regardless of ambient temperature.

- ON APU:

  30 seconds maximum at temperature above 10°C (50°F); two minutes maximum at ambient temperatures below 10°C (50°F).

Normally, airframe anti-icing is not used before takeoff, except to check its operation or, in some cases, to preheat the surfaces. If tested or preheated using APU bleed air, increases in APU EGT's will be noted immediately. In this case, it is suggested only one system at a time be activated.

The use of engine anti-icing is required during all ground and flight operations with icing conditions or visible moisture such as rain, fog, or high humidity with a temperature of +10°C (+50°F) or lower.

When holding on-the-ground in conditions below +10°C (+50°F) with fog or rain and with engine anti-icing selected to ON, it is recommended that the engines be accelerated to approximately 90% N2 RPM for 3 to 4 seconds and at intervals of not more than 8 minutes. This will insure rotor/stator icing at low engine speeds will be kept within acceptable limits before takeoff.

Maximum engine anti-ice pressure is 60 PSI. There is no minimum.

(cont'd.)

ICE & RAIN PROTECTION SYSTEM DESCRIPTION

NORMAL OPERATION OF ANTI-ICING SYSTEMS (ENGINE, WING, & TAIL) (cont'd.)

Before Takeoff (cont'd.)

No airframe anti-icing is required for takeoff, but in known or forecast icing conditions, airframe anti-icing is normally selected following changeover from APU bleed at approximately 3,000 feet AGL. If anti-icing is necessary prior to this altitude, it is permissible to changeover above 400 feet AGL and at takeoff power. When in use, all anti-ice switches are normally ON. Select all four switches to ON when initiating anti-icing.

The changeover from APU bleed must be completed and duct pressure stabilized before airframe anti-icing is selected ON.

In Flight

In flight, engine and airframe (wing and tail) anti-icing are intended to be operated together. It is particularly important to use wing anti-icing, along with engine anti-icing, to prevent ice forming on the wings and shedding into the engines. It is recommended that low-energy engine ignition be selected ON before turning on engine anti-icing and left ON until engine stability is assured to reduce exposure to engine flame-out due to airflow instability. The use of low-energy engine ignition is highly recommended if there has been a delay in selecting engine anti-icing ON or, if there is an accumulation of ice noted.

When anti-icing is required, it must be switched ON in the following order: (1) ENGINE, (2) WING, and (3) TAIL. The switches should be turned ON individually, pausing momentarily to allow pneumatic pressure to stabilize before turning ON the next switch.

Turn ON anti-icing under the following circumstances:

- Before entering known or suspected icing conditions.

- Any time ice accretion is visible on the hot rod or windshield posts.

- Icing conditions or visible moisture such as rain, fog, or high humidity with a temperature of +10°C (+50°F) or lower.

After anti-icing is turned ON for any of the preceding reasons, it may be turned OFF when no ice accretion is visible on the hot rod, but the hot rod must be monitored at frequent intervals while possible icing conditions exist.

Whenever anti-icing is turned ON, check anti-icing pressure and wing and tail anti-icing temperature.

During descent with anti-icing ON, N2 RPM should not be reduced below 72% to assure adequate cabin ventilation rate is maintained.

In severe icing conditions at low engine RPM, engine vibration may be high and may even exceed the engine shutdown limits. However, in this case, vibration indication may be ignored, unless accompanied by some other evidence of engine malfunction.

CAUTION: Rapid throttle lever movement in icing conditions should be avoided.

(cont'd.)

ICE & RAIN PROTECTION SYSTEM DESCRIPTION

NORMAL OPERATION OF ANTI-ICING SYSTEMS (ENGINE, WING, & TAIL) (cont'd.)

In Flight (cont'd.)

Airframe anti-Icing temperatures are as follows:

- Acceptable anti-icing MINIMUM temperatures as indicated on the cockpit wing and tail temperature gauge normally requires near cruise power:
  - Light to Moderate Icing: 150°C
  - Heavy Icing: 180°C
- The MAXIMUM acceptable anti-icing temperature indicated is normally 283°C.

Landing

If wing and tail anti-icing are ON during final approach, the engines will be the normal pneumatic source. Airframe anti-icing must be turned OFF just prior to closing throttles for landing. Leave engine anti-icing ON.

In the event of a go-around in icing conditions if wing and tail anti-icing have already been turned OFF, turn them back ON after a positive rate of climb is established and landing gear is retracted.

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ICE & RAIN PROTECTION SYSTEM DESCRIPTION

WINDSHIELD AND SIDE WINDOW HEAT

General Description

All cockpit windows incorporate a metallic-film heating element. The side windows are heated only at a low level for anti-fogging. The windshields can be heated at either a low level or a high level for anti-fogging, anti-icing, and bird impact resistance.

Controls & Indicators

All controls and indicators for window heat are located on the cockpit overhead panel.

Side Window Switch

This two-position switch (ON/OFF) controls power to all four side windows. When the switch is ON, side window temperature is automatically kept from exceeding about 35°C (95°F).

Windshield Switch

This three-position switch (HIGH/OFF/LOW) controls power to the two forward windshield panels. With the switch in either the HIGH or LOW position, windshield temperature is automatically kept from exceeding about 35°C (95°F). The HIGH position provides a higher voltage at the windshields than does LOW to increase the heating capability within the same temperature limit.

Overheat and Underheat Lights (4)

These amber lights illuminate when the temperature on the respective windshield panel is above or below the normal operating level.

Operation of Windshield Heat

Windshield heat must be switched to LOW and side window heat must be switch ON before starting engines to assure proper preheating.

If windows are cold-soaked, warm gradully by 10-second cycling between OFF and LOW for about one minute.

On-the-ground with extreme high or low OAT, it is normal to have OVERHEAT or UNDERHEAT lights illuminated with the windshield heat selected OFF.

- With low OAT, UNDERHEAT lights will normally extinguish with windshield heat selected to LOW.

- With high OAT, OVERHEAT lights may illuminate with windshield heat switch in any position. If in the HIGH position, select LOW. If in the OFF or LOW position, no action is required.

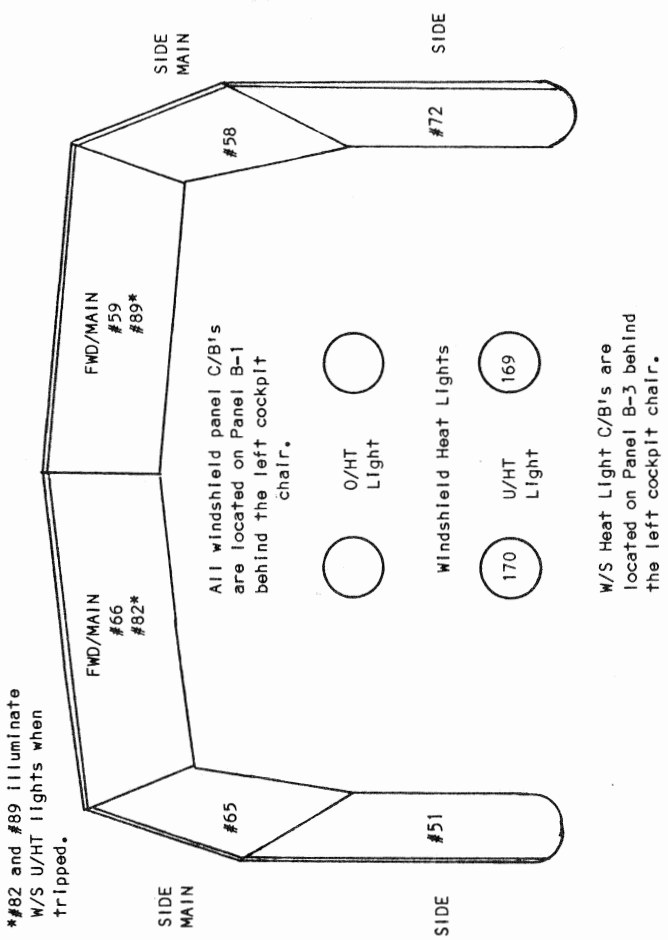
If the temperature on the ground is below -15°, windshield heat must be set from LOW to HIGH. In flight, if the temperature is below -5°C or if the UNDERHEAT lights are illuminated, windshield heat must also be set from LOW to HIGH.

(cont'd.)

ICE & RAIN PROTECTION SYSTEM DESCRIPTION

WINDSHIELD AND SIDE WINDOW HEAT (cont'd.)

Circuit Breaker Layout for Windshield and Side Windows



ICE & RAIN PROTECTION SYSTEM DESCRIPTION

PITOT HEAD, SAT/TAS PROBE, AND STALL WARNING VANE ANTI-ICE

General Description

Each of the five pitot heads on the airplane (Captain's, First Officer's, Auxiliary, Left Q, and Right Q) and the Static Air Temperature (SAT)/True Air Temperature (TAT) probe are heated by a self-contained electrical heating element. The four vanes for the stall warning system (shaker and pusher) are also heated by electrical elements.

Controls & Indicators

Pitot Heaters Switches (5)

These five switches control operation of the electric heaters in the pitot heads, SAT/TAS probe, and stall warning vanes. The switches marked "Q" control the left and right "Q" heaters and left and right forward (stickpusher) stall warning heaters. The switch marked "LEFT" controls the left (Captain's) pitot heater and left aft (stickshaker) stall warning vane heater. The switch marked "RIGHT" controls the right (First Officer's) pitot heater, the right aft (stickshaker) stall warning vane heater, and the SAT/TAS probe heater.

The three-position switch marked STATIC TEST-OFF-PITOT/STATIC ON turns on the heater in the auxiliary pitot head when selected to the PITOT/STATIC ON position. The STATIC ON portion of this position is deactivated as is the complete STATIC TEST position.

The SAT/TAS probe heater is wired through the main landing gear (MLG) safety switches. Heat will be activated to the probe only with the RIGHT pitot heat control switch ON and the gear safety switches in the FLIGHT mode. The probe is not heated on the ground.

Pitot Heater Ammeters (4)

The four ammeters above the Pitot and "Q" heat switches show the current being drawn by the respective pitot head heater. The meters do not show current draw of the stall warning vane heaters. The meter marked LOWER shows current draw of only the auxiliary pitot head heater when the adjacent switch is in the PITOT/STATIC ON position. There is no cockpit indication of SAT/TAS probe heater operation.

Stall Warning Heaters Fail Lights (4)

These amber lights illuminate when the respective pitot heat switch is OFF, or when the pitot heat switch is ON and the stall warning vane heater is INOPerative.

Pitot Heat Monitor

Two annunciator lights marked "L PITOT HEAT" and "R PITOT HEAT" are located on the First Officer's flight panel. They give immediate indications of pitot heat failure when illuminated. They are extinguished by turning ON the Captain's and First Officer's pitot heat switches. The circuit breaker controlling this protective circuitry is located on Panel B-4, labeled PITOT HT WN. This circuit breaker also protects the "BRT/DIM" feature of the annunciator lights.

Illumination of these lights, on the ground or in flight while the pitot heat switches are ON, should be backed up by observing the respective ammeter and, if failed, should be treated as a PITOT HEAT FAILURE EMERGENCY.

(cont'd.)

ICE & RAIN PROTECTION SYSTEM DESCRIPTION

PITOT HEAD, SAT/TAS PROBE, AND STALL WARNING VANE ANTI-ICE (cont'd.)

Pitot Heat Operation

All pitot heaters are normally turned ON before takeoff and left ON until after landing.

Amperage should show approximate mid-scale. With failure of a pitot heat probe, the switch should remain ON to heat the stall vanes.

ICE & RAIN PROTECTION SYSTEM DESCRIPTION

WINDSHIELD WIPER SYSTEM

General Description

Two variable speed, hydraulically operated windshield wipers are provided to maintain areas of clear visibility during precipitation. The Captain's wiper operates from the aircraft's No. 2 hydraulic system and the First Officer's from the No. 1 system.

Controls & Indicators

Rotary control switches, located on the center pedestal, control individual blade speed.

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ICE & RAIN PROTECTION SYSTEM DESCRIPTION

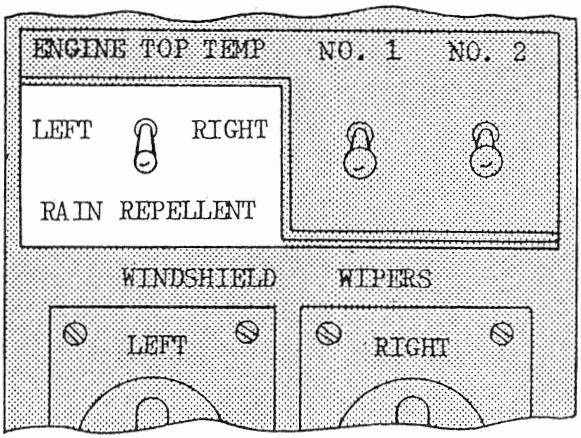
RAIN REPELLENT SYSTEM

General Description

The rain repellent system is to be used in conjunction with the windshield wiper system to improve windshield visibility during heavy rain conditions. The system uses a special fluid which is sprayed onto the windshields from a spray nozzle located at the base of the windshield.

The rain repellent system will not function as a window washer and should NEVER be used on a DRY windshield or in light misty rain. In the event of inadvertent application on a dry windshield, DO NOT operate the windshield wipers as this will only spread the fluid and may obscure visibility.

Controls & Indicators



Control Switch

A three-position toggle switch when activated allows a predetermined quantity of fluid to be sprayed onto the selected windshield. The control switch should be held in the LEFT or RIGHT position until the spray has ceased. On some airplanes, the switch may be a lock-toggle type.

Container and Reservoir

The aerosol container is located above and connected directly to a translucent reservoir mounted on the bulkhead behind the First Officer's seat. A red plastic ring, which floats on top of the fluid, serves as the indicator for the sight gauge. When the fluid reaches the lower half of the reservoir (marked in red), the container should be replaced.

(cont'd.)

ICE & RAIN PROTECTION SYSTEM DESCRIPTION

RAIN REPELLENT SYSTEM (cont'd.)

Operation

Rain repellent may be used in rainfall of any intensity. It is most effective in areas where the windshield wipers are operating; however, it also works in unwiped areas. In "very light" rain, it may cause a grey jelly-like substance to form in unwiped areas. The substance is easily removed in wiped areas.

Operate the windshield wipers at 1/2 or higher speed.

Hold the rain repellent switch to either the LEFT or RIGHT position until flow of repellent solution ceases, then release the switch. When flow of repellent stops, repeat application to the other windshield. Repeat applications as required.

NOTE: The length of time that a repellent application remains effective varies inversely with rain intensity (more rain, less duration). An application lasts 3 to 4 times longer in wiped areas than in unwiped areas. The repellent effect can be maintained indefinitely in wiped areas by repeated application, but becomes ineffective in unwiped areas after repeated applications, until the windshield is wiped or washed on the ground.

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ELECTRICAL SYSTEM DESCRIPTION

GENERAL DESCRIPTION

The basic airplane electrical system is normally supplied with 115/200-volt, 3-phase AC power from two engine-driven generators. Each generator is driven by a constant speed drive and starter unit (CSDS), so as to maintain nominal frequency of 400 CPS.

A third AC generator, driven by the constant speed auxiliary power unit (APU), provides a standby source of AC power in flight, and a normal source of AC power on the ground with the engines shut down.

A static inverter is installed to provide an emergency source of 115-volt AC power to certain essential AC systems.

DC power is normally generated by two transformer/rectifier units (TRU's) that convert AC power to 28-volt DC power. An emergency source of DC power is provided by two 24-volt lead-acid batteries.

An external source of 115/200-volt AC power can be connected to a receptacle on the left side of the nose to supply all normal AC loads.

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ELECTRICAL SYSTEM DESCRIPTION

AC POWER DISTRIBUTION SYSTEM

General Description

There are three primary AC buses provided on the airplane:

- No. 1 AC Bus
- No. 2 AC Bus
- Essential AC Bus

The No. 1 and No. 2 AC buses can be interconnected by a Split System Breaker (SSB) installed, schematically speaking, between the two buses. External power can be connected directly to the No. 2 AC bus.

Functionally, the AC power system is automatic, such that in flight, any single failure will not leave an AC bus without a source of power. The system contains a series of electrical interlocks to prevent more than one source of power from being applied to any one bus any time. The generators on the aircraft never operate in parallel.

The No. 1 and No. 2 AC buses are normally supplied by their respective generators through their Generator Circuit Breakers (GCB's). The GCB's close automatically, and remain closed when generator output (voltage and frequency) is above a predetermined value.

If an engine generator becomes inoperative, the respective bus will then be powered in one of two ways as follows:

- If the APU is not operative, the respective APU GCB will close automatically to connect the APU generator to the bus, or

- If the APU is not operating, the SSB will close automatically to connect the No. 1 and No. 2 AC buses together, thus one engine generator will carry both buses.

The ESS AC bus is normally supplied directly from the No. 1 AC bus, through contacts in the ESS AC changeover relay. If for any reason there is no power on the No. 1 AC bus, the relay will automatically "start" the inverter and connect its output to the ESS AC bus.

The APU generator will supply all three AC buses on the ground with both engines shut down. In this case, both APU generator GCB's are closed, connecting the APU generator to No. 1 and No. 2 AC buses, and the SSB is open. The APU generator automatically takes priority over external AC power.

External AC power is applied directly to the No. 2 AC bus when the external power contactor is closed. In this case, the SSB is closed automatically and the No. 1 AC bus is powered from the No. 2 AC bus; the ESS AC bus is, of course, powered from the No. 1 AC bus. Any other power source, engine or APU generator, takes priority over external power.

When external AC power is connected to the aircraft, it will, in addition to illuminating the ground power light, provide power to the galley/cabin plug-type outlets; illuminate some galley and cabin lights for galley and cabin servicing; and provide power to the external power TR for illuminating numerous service-type lights throughout the aircraft.

Supplied by Jeppesen Sandersor

ELECTRICAL SYSTEM DESCRIPTION

AC POWER DISTRIBUTION SYSTEM (cont'd.)

Controls & Indicators

All controls and indicators for the AC system are located on the cockpit overhead panel.

CSD Fail Lights (Amber) (2)

These amber lights, one for each CSDS, illuminate when oil pressure in the respective CSDS is below a predetermined value. They will be illuminated before the engines are started, and will extinguish during engine starting when oil pressure in the CSDS reaches a normal value.

CSD Disconnect Switches (2)

These switches, with NORMAL/DISCONNECT positions, are used to disconnect a malfunctioning CSDS or generator from the engine. Once disconnected, the CSDS must be reconnected on the ground by Maintenance.

KVA Meters (3)

These meters provide an indication of the apparent power, both real load and reactive load, being supplied by the respective AC generator. Generator load limits are observed by reference to these meters.

Voltage and Frequency Meters and Selector

A voltmeter and a frequency meter permit checking parameters at various points in the AC system. Selections available are: EXT (external power)/NO. 1 GEN/APU GEN/NO. 2 GEN/ESS (essential AC bus).

AC Bus Fail Lights (Red) (2)

These red lights, one for the No. 1 AC bus and one for the No. 2 AC bus, illuminate when voltage on the respective bus drops below a predetermined value.

Generator Fail Lights (3)

These lights illuminate to indicate that the respective generator circuit breaker(s) (GCB) is open, and the generator is not connected to a load. However, the APU generator fail light remains extinguished even when both of its GCB's are open, provided both engine generator GCB's are closed. If an engine generator GCB opens and an APU GCB remains open when it should close, the APU generator fail light then illuminates. In other words, the APU generator fail light illuminates only when an APU GCB is not closed when it should be closed.

Generator Control Switches (3)

These three-position switches control operation of the respective generator circuit breaker(s) as follows:

- NORMAL ---------- Allows GCB to open and close automatically as a function of generator voltage and frequency, and demand in the case of the APU generator.

- TRIP (Momentary) - Opens GCB to disconnect generator from load bus and opens generator exciter circuit to reduce generator output to zero.

- RESET (Momentary)- Closes generator exciter circuit following manual or automatic trip. GCB will close when voltage and frequency are up to normal.

(cont'd.)

ELECTRICAL SYSTEM DESCRIPTION

AC POWER DISTRIBUTION SYSTEM (cont'd.)

Controls & Indicators (cont'd.)

Static Inverter Test Switch

This switch permits checking the static inverter with power applied to the No. 1 AC bus. When the switch is moved to the (momentary) TEST position, the AC changeover relay is de-energized such that the inverter is powered by the ESS DC bus, provided the battery switch is ON, and the output of the inverter is connected to the ESS AC bus. The position of the AC changeover relay can be checked by reference to the inverter annunciator. Inverter output can be checked by moving the frequency/voltmeter selector to the ESS position.

Static Inverter Annunciator

This annunciator shows the source of power for the ESS AC bus. It illuminates MAIN when power is supplied from the No. 1 AC bus, the normal source and it illuminates INVERT when power is supplied from the inverter. When no power is applied to the annunciator, it will give an "amber" indication.

Ground (External) Power Switch and Light

The three-position ground power switch controls operation of the ground power relay (contactor) to connect or disconnect the ground power unit (GPU) generator to the airplane's electrical system.

When the switch is moved to the (momentary) CLOSE position, the ground power relay is closed provided no other source of power, engine or APU generator, is available to the No. 1 and No. 2 AC buses, providing the batteries are ON.

The (momentary) TRIP position opens the relay.

The relay will open automatically if the switch is in the center (unmarked) position and another source of power becomes available to the No. 1 or No. 2 AC bus.

The light is illuminated whenever a live source of ground power is plugged into the ground power receptacle, whether or not the ground power relay is closed.

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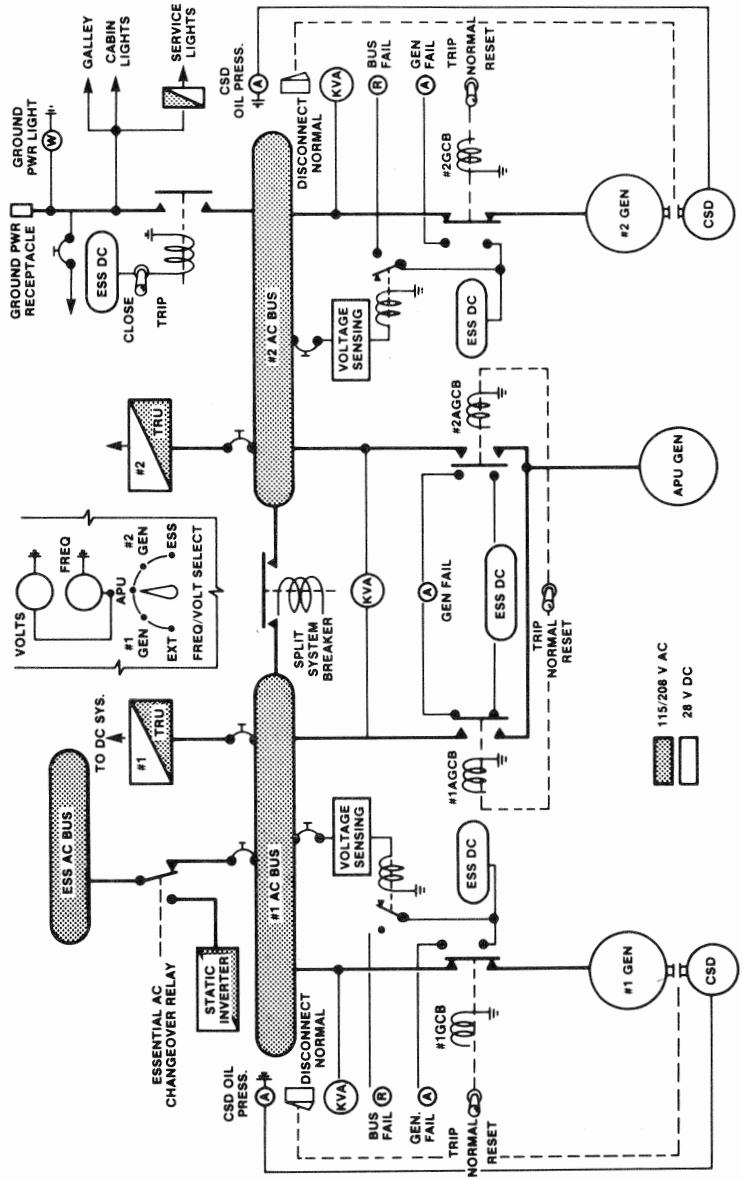
ELECTRICAL SYSTEM DESCRIPTION

AC ELECTRICAL POWER SYSTEM SCHEMATIC



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ELECTRICAL SYSTEM DESCRIPTION

DC POWER DISTRIBUTION SYSTEM

General Description

There are three primary DC buses provided on the airplane:

- Battery Bus,
- ESS DC Bus, and
- Main DC Bus.

All three buses are connected together during normal operation as explained later in this section.

The battery bus is connected directly to the aircraft batteries. The battery bus is "hot" as long as batteries are installed in the airplane. It is connected to the ESS DC bus through the battery relay when the battery switch is ON.

The ESS DC bus and the main DC bus are powered from the No. 1 and No. 2 TRU's respectively. The TRU's are powered from the No. 1 and No. 2 AC buses respectively. The main DC and the ESS DC buses are automatically connected together through the main bus isolation relay so long as the voltage on the main DC bus reaches about 26 volts, and the buses remain connected together until voltage on the main DC bus drops to about 24.5 volts.

The static inverter is powered from the ESS DC bus, provided the battery switch is ON, whenever there is no power on the No. 1 AC bus. The inverter converts DC power to 115-volt AC power and, in turn, powers the ESS AC bus.

ELECTRICAL SYSTEM DESCRIPTION

DC POWER DISTRIBUTION SYSTEM (cont'd.)

Controls & Indicators

All controls and indicators for the DC system are located on the cockpit overhead panel.

TRU Ammeters

These indicate the amperage (load) being supplied by the respective TRU and they are red-lined at 150 amps.

Battery Ammeter

This indicates the amperage to and from the aircraft batteries when they are being charged (+) or discharged (-).

Battery Switch and Annunciator

In the ON position, the battery switch closes the battery relay to connect the batteries to the ESS DC bus. The annunciator shows the position of the battery relay, i.e., it shows ON when the relay is closed and OFF when the relay is open. The battery relay can also be closed by placing the fueling power switch to ON or the DC (hydraulic) pump switch to the BRAKE ACC position. In either case, the annunciator will show ON when the relay is closed. The battery switch must be in the ON position in order for the static inverter to operate.

DC Voltmeter

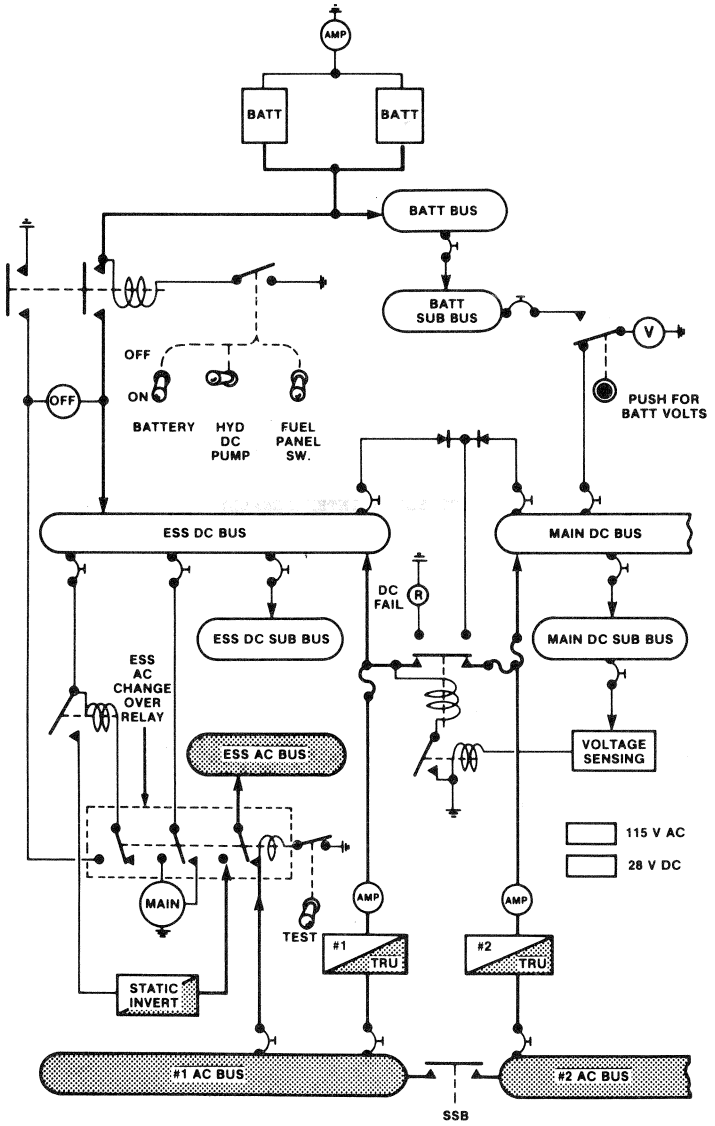
Normally, this voltmeter indicates the voltage on the main DC bus. Since the main DC and ESS DC buses are normally connected together through the main bus isolation relay, it also indicates voltage on the ESS DC bus during normal operation. A pushbutton adjacent to the voltmeter marked PUSH FOR BATT VOLTS, connects the voltmeter to the battery bus (actually the battery sub-bus). Thus with the battery relay open, the voltmeter reads battery voltage (about 24 volts). With the battery relay closed and TRU power applied to the ESS DC bus, it will read battery charging voltage (about 28 volts).

DC Fail Light

This red light indicates that the main bus isolation relay is open, which probably indicates a failure of either the main DC bus or the ESS DC bus. However, since other malfunctions besides a bus failure can cause this relay to open and the light to illuminate, verification of a bus failure should be made by using the TRU ammeters or the DC voltmeter.

ELECTRICAL SYSTEM DESCRIPTION

DC ELECTRICAL POWER SYSTEM SCHEMATIC



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ELECTRICAL SYSTEM DESCRIPTION

ELECTRICAL LOAD SHEDDING

An electrical load reduction circuit is provided to automatically deactivate the galley and/or air conditioning blower to reduce exposure to exceeding AC generator output capabilities. (The load reduction circuit will not function when ground power is supplied by an external source.) The functions of this circuit are as follows:

Air conditioning blower in flight:

- No air conditioning blower if on one generator operation. (Blower normally on in flight at 165 KIAS and lower and landing gear down.) Not applicable on the ground; blower will operate.
- No air conditioning blower operation if No. 2 aux. hydraulic pump ON. Not applicable on the ground; blower will operate.

No. 1 and No. 2 galley power:

- No No. 1 or No. 2 galley if on one generator operation and both aux. hydraulic pumps are selected ON. Applicable in flight or on the ground.
- No No. 2 galley with air conditioning blower operating. Applicable in flight or on the ground.

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ELECTRICAL SYSTEM DESCRIPTION

CIRCUIT BREAKER PANELS

General Description

Circuit breaker panel inspection lights are mounted on all panels except Panel "P" which is integrally illuminated. The control switch is located adjacent to the right cockpit speaker.

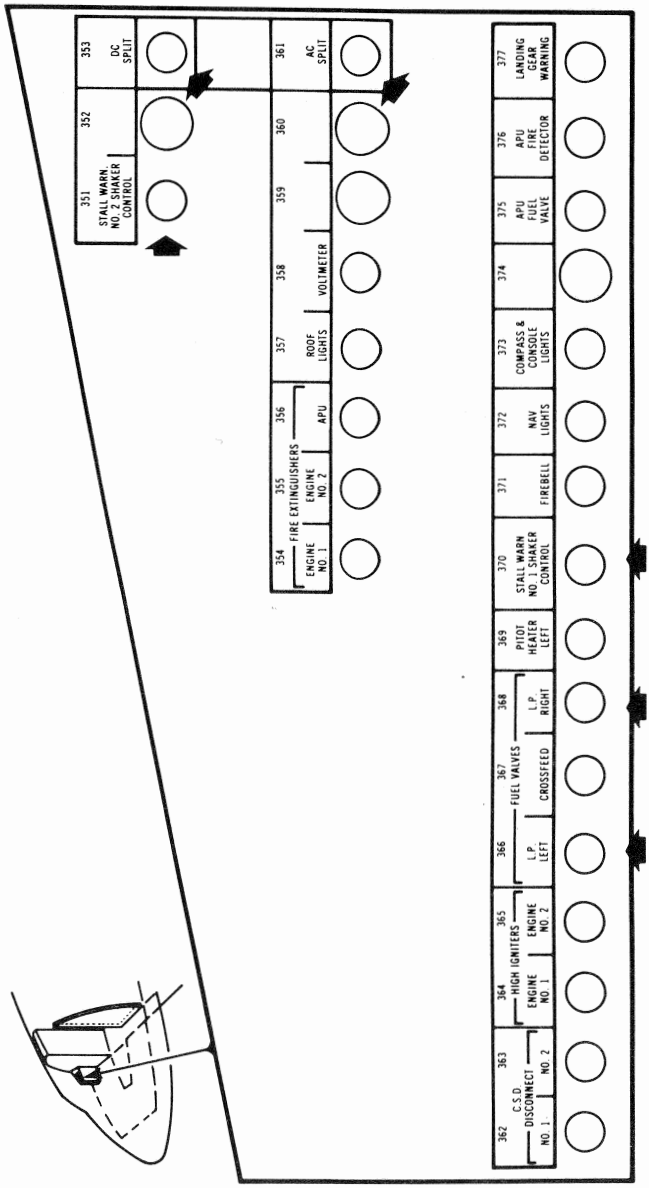
The lights are powered from the main DC bus through the "Chart Light-F/O" breaker (Panel B-3, C/B #119).

DO NOT reset a tripped main fuel boost pump or transfer pump circuit breaker.

ELECTRICAL SYSTEM DESCRIPTION

CIRCUIT BREAKER PANELS (cont'd.)

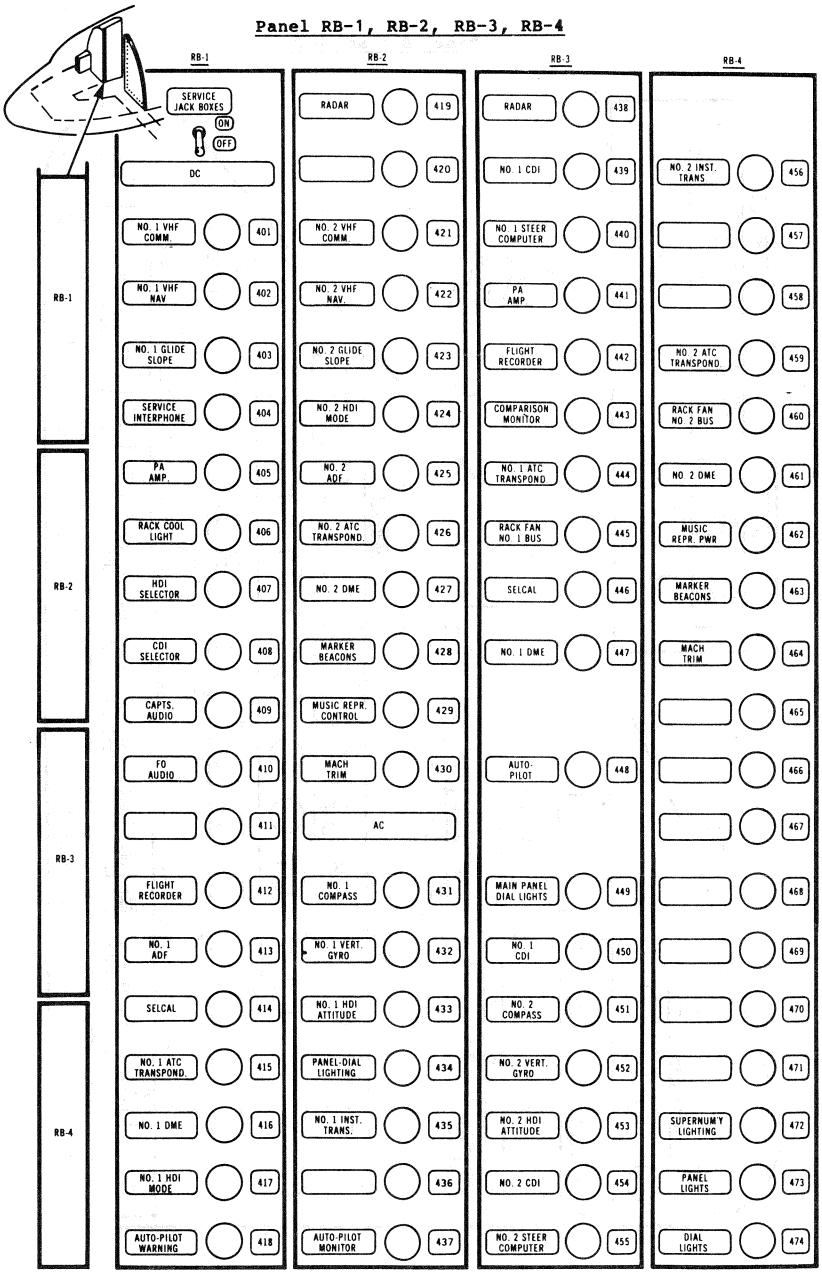
Panel P



ELECTRICAL SYSTEM DESCRIPTION

CIRCUIT BREAKER PANELS (cont'd.)

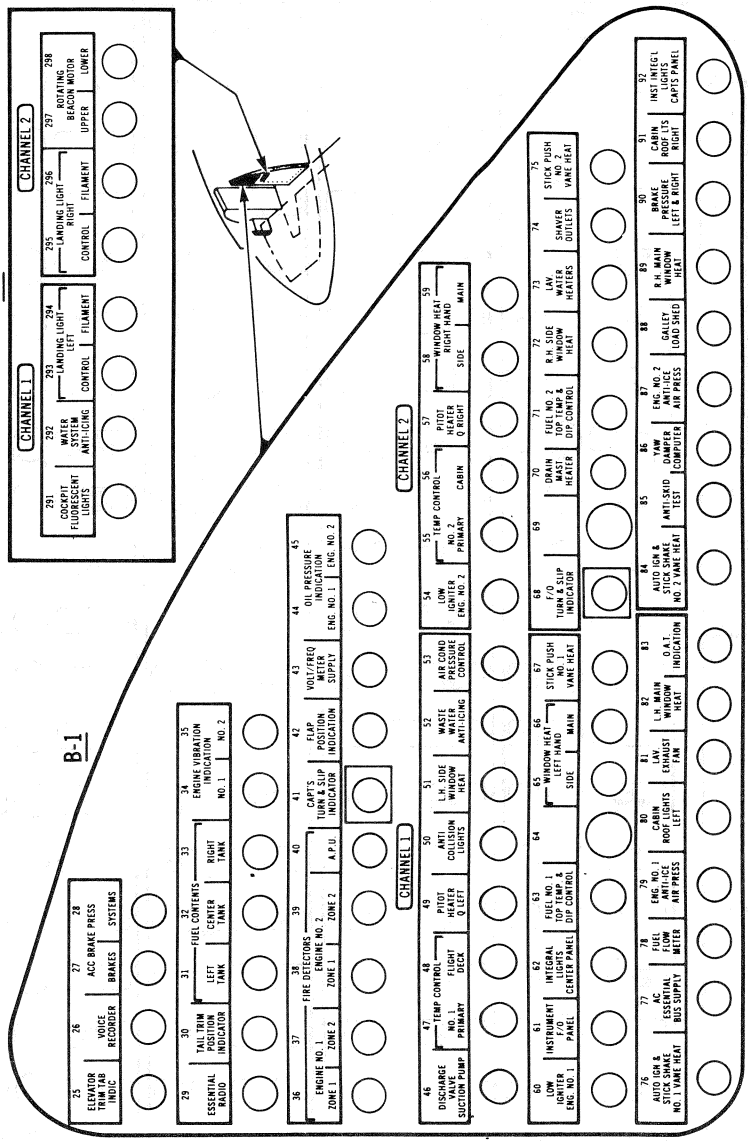
Panel RB-1, RB-2, RB-3, RB-4



ELECTRICAL SYSTEM DESCRIPTION

CIRCUIT BREAKER PANELS (cont'd.)

Panel B-1 and B-2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292 WATER SYSTEM ANTI-ICING
293 LANDING LIGHT LEFT CONTROL
294 FILAMENT
295 LANDING LIGHT RIGHT CONTROL
296 FILAMENT
297 ROTATING BEACON MOTOR UPPER
298 LOWER
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27 ACC BRAKE PRESS BRAKES
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30 TAIL TRIM POSITION INDICATOR
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48 FLIGHT DECK
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53 AIR COND PRESSURE CONTROL
54 LOW IGNITER ENG. NO. 2
55 TEMP CONTROL NO. 2 PRIMARY
56 CABIN
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59 MAIN
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64
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68 F/O TURN & SLIP INDICATOR
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70 DRAIN MAST HEATER
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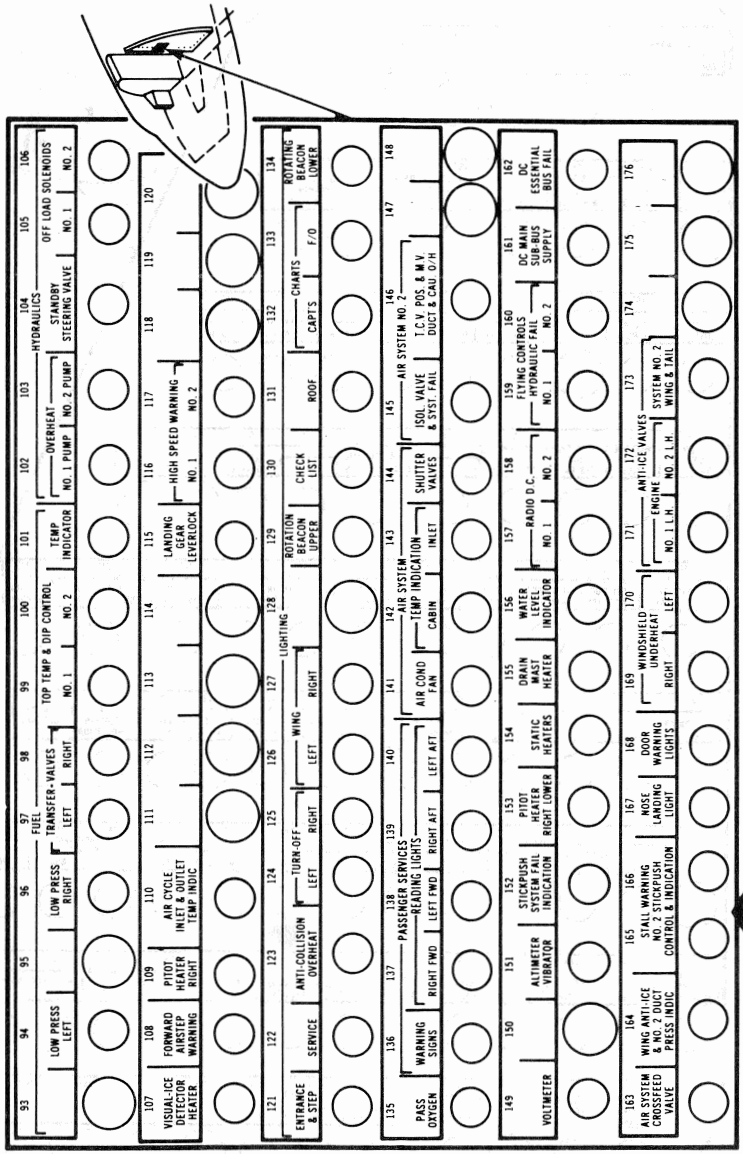
72 R.H. SIDE WINDOW HEAT
73 LAV WATER HEATERS
74 SHAVER OUTLETS
75 STICK PUSH NO. 2 VANE HEAT
76 AUTO IGN & STICK SHAKE NO. 1 VANE HEAT
77 AC ESSENTIAL BUS SUPPLY
78 FUEL FLOW METER
79 ENG. NO. 1 ANTI-ICE AIR PRESS
80 CABIN ROOF LIGHTS LEFT
81 LAV EXHAUST FAN
82 L.H. MAIN WINDOW HEAT
83 O.A.T. INDICATION
84 AUTO IGN & STICK SHAKE NO. 2 VANE HEAT
85 ANTI-SKID TEST
86 YAW DAMPER COMPUTER
87 ENG. NO. 2 ANTI-ICE AIR PRESS
88 GALLEY LOAD SHED
89 R.H. MAIN WINDOW HEAT
90 BRAKE PRESSURE LEFT & RIGHT
91 CABIN ROOF LTS RIGHT
92 INST INTEGL LIGHTS CAPT'S PANEL

ELECTRICAL SYSTEM DESCRIPTION

CIRCUIT BREAKER PANELS (cont'd.)

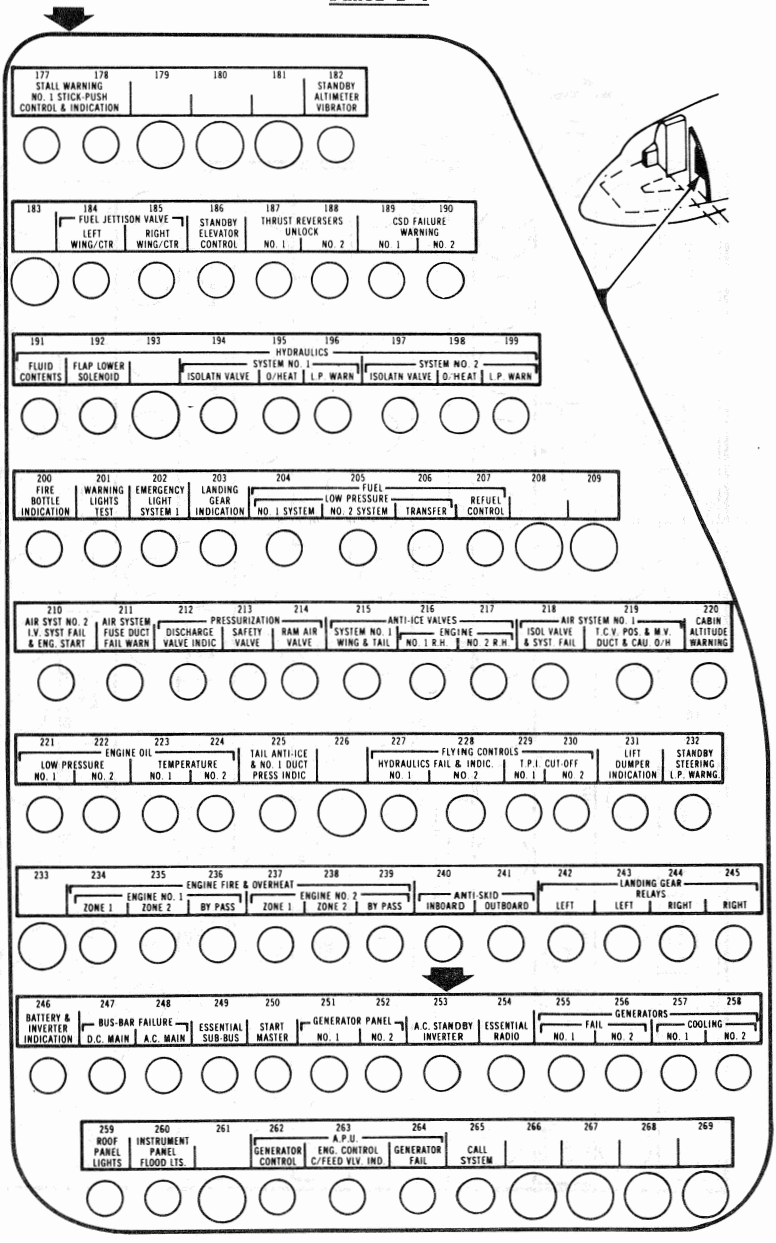
Panel B-3



ELECTRICAL SYSTEM DESCRIPTION

CIRCUIT BREAKER PANELS (cont'd.)

Panel B-4


177 178 STALL WARNING NO. 1 STICK-PUSH CONTROL & INDICATION
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227 228 FLYING CONTROLS HYDRAULICS FAIL & INDIC. NO. 1 NO. 2
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232 STANDBY STEERING L.P. WARNG.
233
234 235 236 ENGINE FIRE & OVERHEAT ENGINE NO. 1 ZONE 1 ZONE 2 BY PASS
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265 CALL SYSTEM
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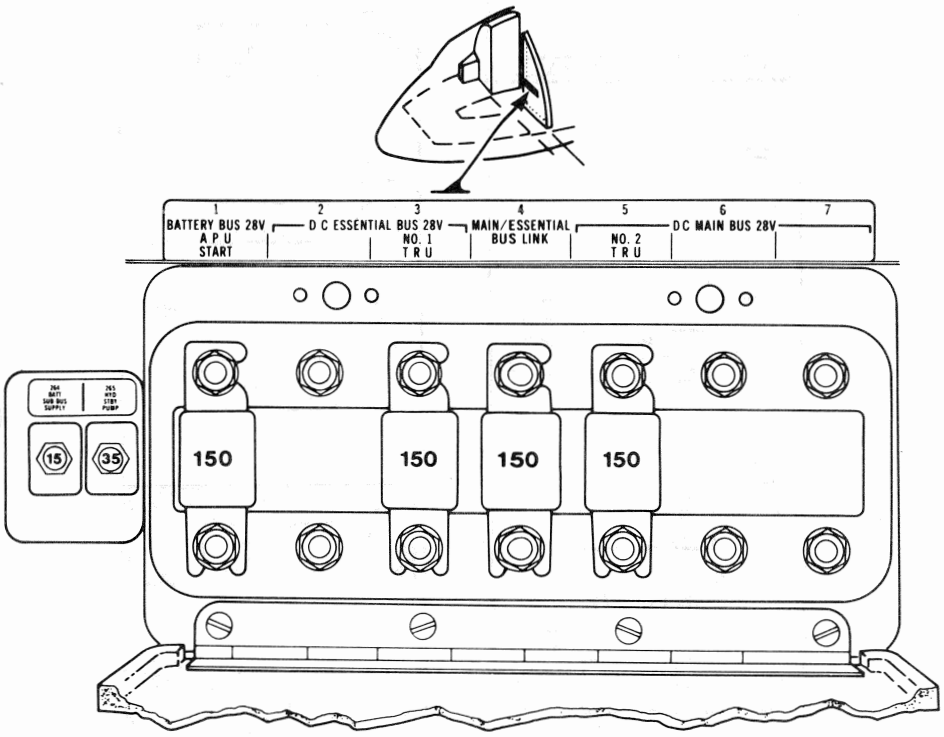
ELECTRICAL SYSTEM DESCRIPTION

CIRCUIT BREAKER PANELS (cont'd.)

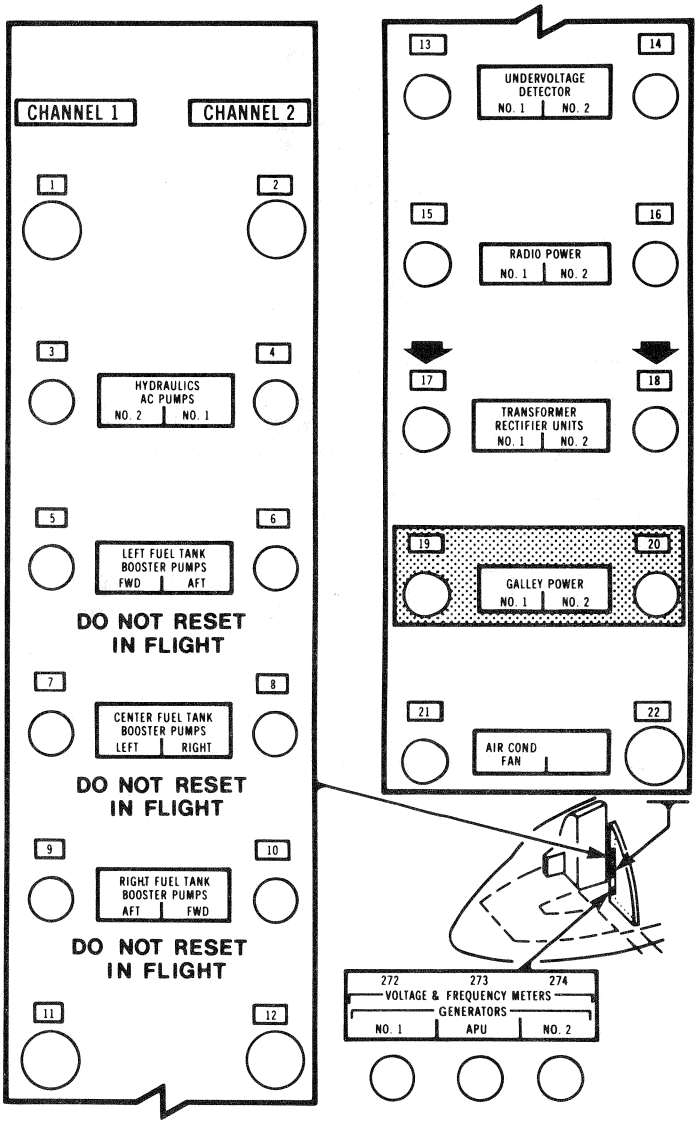
Panel B-5



ELECTRICAL SYSTEM DESCRIPTION

CIRCUIT BREAKER PANELS (cont'd.)

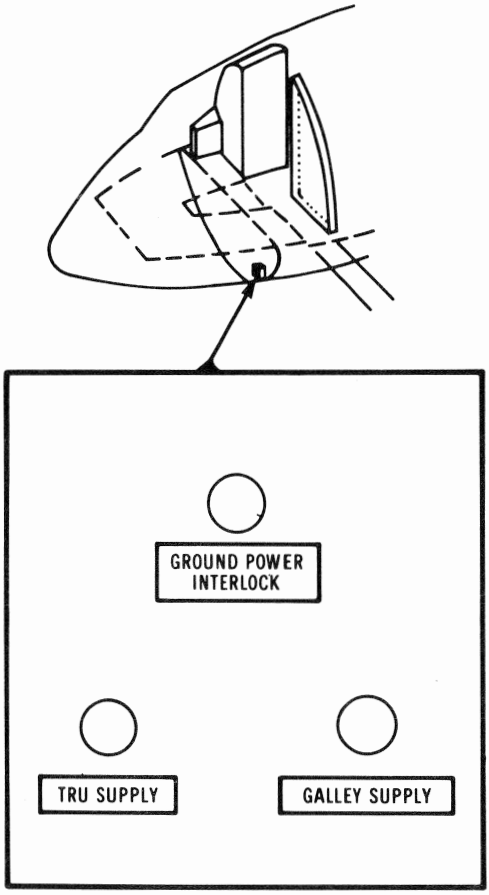
Panel B-6



ELECTRICAL SYSTEM DESCRIPTION

CIRCUIT BREAKER PANELS (cont'd.)

Ground Power Supplies



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ELECTRICAL SYSTEM DESCRIPTION

STATIC INVERTER CHECK

Battery Switch - ON.

Freq/Volt Selector - ESS.

Inverter Test Switch - TEST. Annunciator should move from MAIN to INVERT when switch is moved. This indicates that AC changeover relay has moved.

ESS Voltage and Frequency - CHECK. This checks that inverter AC output is actually being applied to ESS AC bus.

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ELECTRICAL SYSTEM DESCRIPTION

CSDS OIL SERVICING

Normal Method

Normally, the CSDS requires little or no on-the-road oil servicing. Over servicing of a CSDS can cause erratic generator operation and, in some cases, a generator trip especially at higher power settings.

If required, service unit to just below the FULL mark on the tube-type sight gauge located in the CSDS service compartment on each engine.

The pressure-type filler connector is clearly marked. The unit uses the same oil as the engines.

Alternate Method

- Remove the plug.
- Funnel in oil.
- Replace the plug.

RECONNECTING A DISCONNECTED CSDS

If it is desired to reconnect the CSDS for engine start after it has been disconnected with the cockpit CSDS disconnect switch, accomplish the following:

- Reposition the CSDS disconnect switch to NORMAL.
- Open cowling. CSDS is located on lower right side of the engine and directly behind the generator.
- While pulling down on the rachet (turning the gearbox), PULL OUT on the reconnect pin located on the forward right side of the CSDS.
- Release pin. If pin is flush with the housing, it is "connected."
- Remove rachet and reinstall plate. Close cowling.
- Carry out procedure for motoring engine to ensure CSDS engagement.

If the engine will not crank:

If the engine will not turn normally, but can be rotated by hand, check the following:

- CSDS disconnect pin is flush.
- Overspeed pin is flush.
- CSDS PRV solenoid pin is flush.

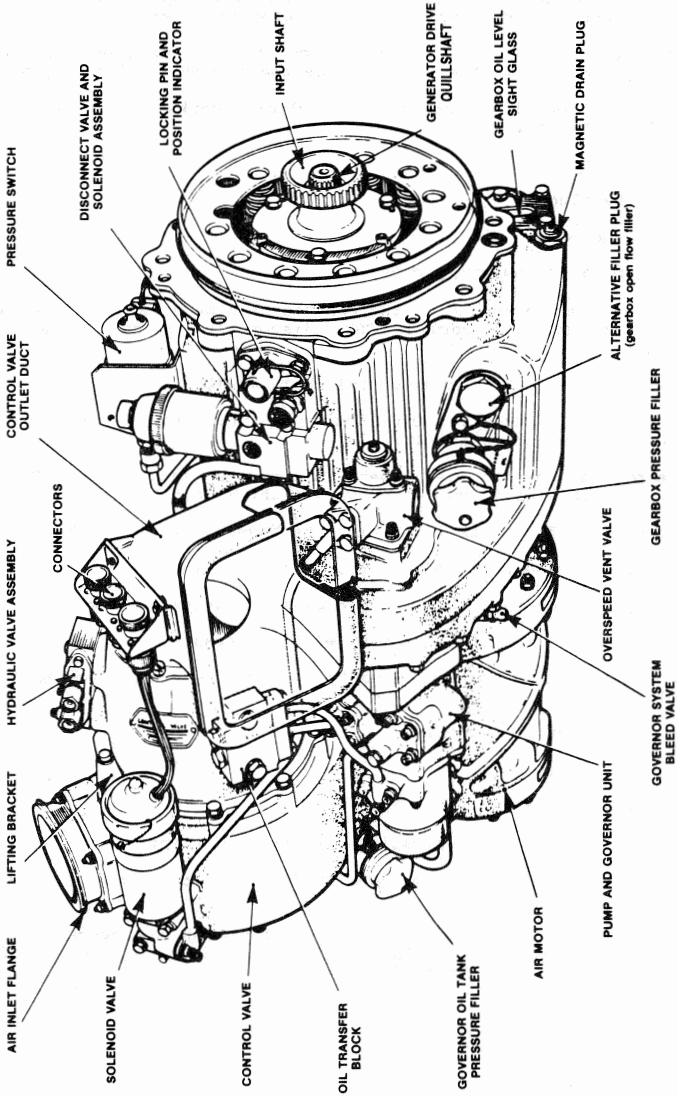
If re-engaging an overspeed trip:

Using a suitable flat-ended metal rod, fully depress the vent valve plunger.

There should be a pronounced "click" indicating the overspeed control assembly has engaged. The plunger sleeve should be approximately 0.100 inches underflush with the spring housing.

ELECTRICAL SYSTEM DESCRIPTION

EQUIPMENT LOCATION ON CSDS



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GENERAL DESCRIPTION

FIRE DETECTION/FIRE PROTECTION

Fire detection and protection is provided for both engines in the area around the accessory section (referred to as Zone 1) and for the auxiliary power unit (APU).

OVERHEAT DETECTION

Overheat detection is provided for both engines in the area around the engine hot section (referred to as Zone 2) and in the engine breather discharge duct.

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FIRE DETECTION

ENGINE FIRE DETECTION

General Description

The engine fire detection system provides a visual and audible indication in the cockpit of a fire in Zone 1 of the engine compartment as follows:

- Visual warning is provided by a light (dual bulbs) in the respective engine fire handle.

- Audible indication is provided by an uninterrupted bell that can be silenced when desired.

Detection is through a continuous loop-type sensing element (called "fire wire") mounted on the inside of the engine cowling doors. The loop contains a special chemical, the resistance of which changes when predetermined levels of heat are applied to it. The loop is unique in that it will still provide a warning even when it is broken. However, a damaged loop will not test properly.

Controls & Indicators

Engine Fire Detector Test Switches (2)

These switches, marked FIRE HANDLE (1 and 2), are located on the forward center instrument panel.

When a switch is placed in the (momentary) TEST position, the lights in the respective fire handle will illuminate and the fire warning bell will sound, provided circuit continuity is complete and power is applied to the ESS AC and DC buses.

When the switch is released, the bell stops sounding and the fire handle lights extinguish automatically.

Fire Warning Bell Cutout Switch and Light

The fire warning bell cutout switch is an integral part of the bell cutout light, located on the forward center instrument panel.

Pulling out on the amber lamp cover will silence the fire warning bell and will prevent any other signal (i.e., from the other engine or APU) from causing the bell to sound.

The light illuminates when the lamp cover is pulled out.

FIRE DETECTION

APU FIRE DETECTION

General Description

The APU fire detection system incorporates several components similar to those used in the engine fire detection system and provides a visual and audible indication as follows:

- Visual warning of an APU fire is through illumination of a light (dual bulbs) in the APU fire handle and a red warning light at the APU external control panel.

- Audible indication is provided by the same bell used for engine fire warning.

Detection is through the same type of continuous loop ("fire wire") as is used for the engines. The loop is mounted around the inside of the APU compartment.

The detection system can be used to provide automatic shutdown of the APU and automatic discharge of the extinguishant, if desired.

Controls & Indicators

APU Fire Detector Test Switch

This switch is located on the forward center instrument panel.

When the switch is placed in the (momentary) TEST position, the light in the APU fire handle will illuminate, the fire warning light at the external APU control panel will illuminate, and the fire warning bell will sound provided circuit continuity is complete and power is applied to the ESS AC and DC buses.

When the switch is released, the bell stops sounding and the fire handle light extinguishes automatically.

NOTE: The APU fire switch must be in the MANUAL position to test the APU fire detection system.

Fire Warning Bell Cutout Switch and Light

The fire warning bell cutout switch is an integral part of the bell cutout light, located on the forward center instrument panel.

Pulling out on the amber lamp cover will silence the fire warning bell and will prevent any other signal (i.e., from the other engine or APU) from causing the bell to sound.

The light illuminates when the lamp cover is pulled out.

FIRE PROTECTION

ENGINE FIRE PROTECTION

General Description

Engine fire protection is provided by two pressurized fire bottles that contain about 6 lbs. of extinguishing agent. Each bottle incorporates two discharge heads, connected so that the extinguishant in the bottle can be discharged to either engine. The extinguishant is released from a bottle by activating either of two small, explosive cartridges incorporated in the bottle heads. When a cartridge is activated, the extinguishant is released to the selected engine and enters Zone 1 of the engine compartment through two spray tubes mounted along the top of the compartment.

The bottles are located on the aft side of the rear pressure bulkhead, just to the left of the rear door. For identification purposes, they are referred to as NO. 1 (left) and NO. 2 (right).

A rupture-type safety disc is incorporated in the head of each bottle. The disc will rupture and discharge the bottle overboard in the event bottle temperature or pressure exceeds a safe level. The overboard discharge ports, located on the lower left side of the aft fuselage, contain a green disc that is blown out if the bottle disc ruptures. When the green disc is missing, the discharge port will be red in color. The forward discharge port is for the No. 2 bottle, the middle port is for the APU bottle, and the aft port is for the No. 1 bottle.

Controls & Indicators

Engine Fire Handles

The engine fire handles, mounted on the glareshield, serve two purposes:

- To shutdown the engine and deactivate certain of its functions, and

- To discharge extinguishant to the engine.

When a fire handle is pulled, it accomplishes the following for that engine:

- Closes the Engine LP Fuel Valve.
- Closes the Hydraulic Pump Isolation Valve.
- Closes the Air Isolation Valve.

After a fire handle is pulled, it can be rotated either clockwise or counterclockwise to fire extinguishant to that engine.

- Rotating the handle to selection "1" (clockwise) fires a cartridge in one of the bottles to discharge the "first shot" of extinguishant to the engine.

- Rotating the handle to selection "2" (counterclockwise) fires the other bottle to release the "second shot" of extinguishant.

For engine No. 1, the "first shot" of extinguishant is from bottle No. 1; the "second shot" is from bottle No. 2. For engine No. 2, the "first shot" is from bottle No. 2 and the "second shot" from bottle No. 1.

Electrical power must be available from the ESS DC bus to fire the "first shot" to either engine. Power from the BATT bus is needed to fire the "second shot" to either engine.

(cont'd.)

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FIRE PROTECTION

ENGINE FIRE PROTECTION (cont'd.)

Controls & Indicators (cont'd.)

Fire Bottle Discharge Annunciators

These annunciators, labeled "1" and "2", are located on the forward center instrument panel. Before the respective bottle is discharged, they are illuminated amber. When the bottle is discharged, the word FIRED will appear in the annunciator and will continue to show as long as electrical power is available on the ESS DC bus until the discharged bottle is replaced.

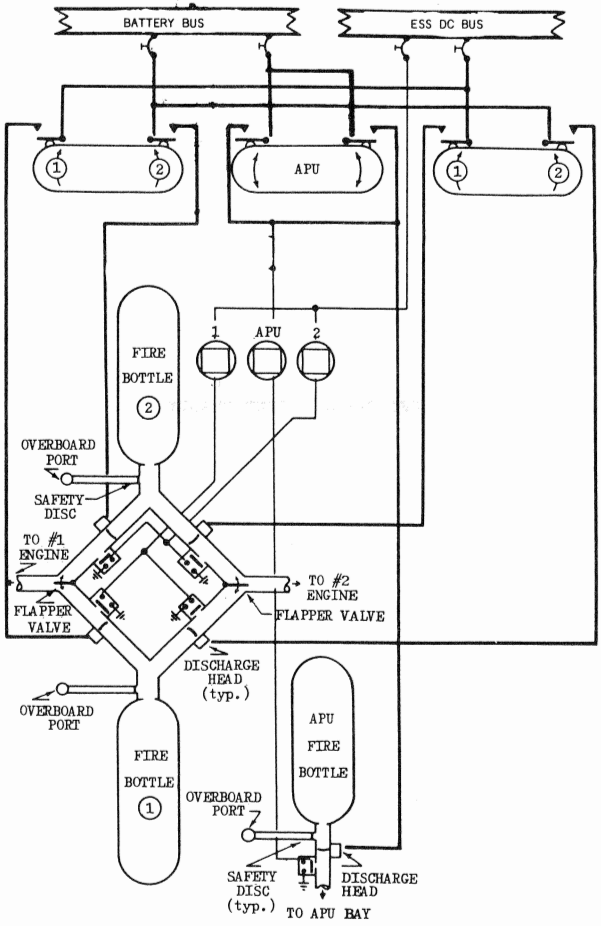
Bottles Fired Indicators

These indicators, located at the APU external control panel, are primarily for use by Maintenance. There are two indicators for each engine fire bottle, one for each cartridge in the bottle head. The indicator is a small glass dome that is clear before the respective bottle-head cartridge is fired and red after firing.

FIRE PROTECTION

ENGINE FIRE PROTECTION

Schematic



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FIRE PROTECTION

APU FIRE PROTECTION

General Description

APU fire protection is provided by a single pressurized fire bottle that contains about 2 lbs. of a freon extinguishing agent. The bottle head incorporates a single explosive cartridge which, when activated, releases the extinguishant to the APU compartment. The extinguishant enters the APU compartment through a single spray tube just in front of the APU.

The APU fire bottle is located on the left side of the rear stairs, just forward of the APU.

Like the engine bottles, the APU bottle contains a rupture-type safety disc. It discharges overboard through the center discharge port on the lower left side of the aft fuselage.

Controls & Indicators

APU Fire Handle

This handle is located between the engine fire handles on the glareshield. It is used to manually shut down the APU in the event of fire and to manually discharge the freon extinguishant. When the handle is pulled, it closes the APU LP and HP fuel valves. When the handle is rotated in either direction, it fires the cartridge in the APU fire bottle and releases the extinguishant to the APU compartment.

APU Fire Switch

This switch, with AUTO/MANUAL positions, is located on the overhead panel. If this switch is in AUTO, APU fire warning will not test.

- With the switch in MANUAL following a fire warning, the APU must be shut down and the extinguishant discharged using either the APU fire handle or the SHUTDOWN and FIRE switches at the external APU control panel.

- With the switch in AUTO following an APU fire warning, the APU will shut down automatically and, about 10 seconds thereafter, the extinguishant will be discharged automatically.

APU Shutdown Switch

This switch, with NORMAL/FIRE positions, is located at the APU external control panel. When the switch is placed to the FIRE position, the APU LP and HP valves are closed to stop the APU and the adjacent Fire Bottle switch is armed.

APU Fire Bottle Switch

This switch, located next to the APU shutdown switch, will fire the APU bottle when it is moved to the EXTINGUISH position, provided the APU shutdown switch is in the FIRE position.

APU Fire Bottle Discharge Annunciator

This annunciator is located on the forward center instrument panel. Before the bottle is charged, it is illuminated amber. When the bottle is discharged, the word FIRED will appear in the annunciator and will continue to show as long as electrical power is available on the ESS DC bus until the discharged bottle is replaced.

(cont'd.)

FIRE PROTECTION

APU FIRE PROTECTION (cont'd.)

Controls & Indicators (cont'd.)

APU Bottle Fired Indicator (cont'd.)

This indicator is located at the APU external control and is primarly used by Maintenance. There are two indicators, one for each cartridge in the bottle head. The indicator is a small glass dome that is clear before the respective bottle-head cartridge is fired and red after firing.

OVERHEAT DETECTION

ENGINE OVERHEAT DETECTION

General Description

The engine overheat detection system provides a visual indication in the cockpit of an overheat in Zone 2 of the engine compartment or overheat in the engine breather discharge duct (LP cooling air discharge duct).

Overheat detection for the engine compartment is through a continuous loop-type sensing element ("fire wire"), similar to that used in the engine fire detection system. It is mounted on the inside of the cowling doors in Zone 2.

Breather duct overheat is detected by a single fenwall-type switch inside the respective breather discharge duct. This detects engine interior deterioration which will usually manifest itself as a high breather discharge temperature.

Controls & Indicators

All switches and lights for the overheat system are located on the forward center instrument panel.

Engine Overheat Lights

These red lights will illuminate, along with the master warning lights, upon receiving a signal from either the overheat loop or the fenwall switch for the respective engine. The signal from the overheat loop will keep the light illuminated only as long as the overheat exists. However, the signal from the fenwall switch will keep the light illuminated until the system is RESET. The light cap on the respective light is pushed in to test the fenwall switch circuit for that engine and is pulled out to cancel the light's input to the master warning circuit.

LP Cooling Reset Switches

When moved to the (momentary) RESET position, these switches will cancel the input to the overheat lights from the respective breather duct fenwall switch. Thus, if the overheat light extinguishes when the switch is held to RESET, the overheat signal is coming from the fenwall switch. If the light does not extinguish when the switch is held, the signal is from the Zone 2 overheat loop which cancels automatically when the loop cools down.

Zone 2 Test Switch

Placing this switch to the (momentary) TEST position will cause both overheat lights to illuminate, provided there is continuity in the respective overheat sensing loop and power is applied to the ESS DC bus. This switch does not test the fenwall switch input to the lights. The lights will extinguish automatically when the switch is released.

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EXTINGUISHING SYSTEMS

GENERAL

The information in this section presents operating instructions for the FIRE PROTECTION SYSTEM ONLY. Concurrent operation of controls of other systems is essential to the overall effectiveness of fire control procedures. Complete fire fighting procedures are outlined in Chapter 1 - EMERGENCY of this manual.

ENGINE FIRE EXTINGUISHING SYSTEM

To discharge extinguishant into engine compartment:

Engine Fire Handle - PULL. This accomplishes the following:

- Closes LP fuel valve.
- Closes engine-driven hydraulic pump isolation valve.
- Closes air isolation valve.

Engine Fire Handle - ROTATE TO "1". This fires one of two bottles to that engine. If No. 1 engine, No. 1 bottle annunciator should show FIRED; if No. 2 engine, No. 2 bottle annunciator should show FIRED.

If second extinguishant discharge to same engine is necessary:

Engine Fire Handle - ROTATE TO "2". This fires second of two bottles to that engine. If No. 1 engine, No. 2 bottle annunciator should show FIRED; if No. 2 engine, No. 1 bottle annunciator should show FIRED.

NOTES:

1) Electrical power to fire bottles in selection "1" for each handle is from ESS DC bus; power to fire bottle in selection "2" is from BATT bus. Therefore, if no power on ESS DC bus, bottles can be fired only in selection "2".

2) Once a bottle is fired, annunciator will continue to show FIRED until bottle is replaced, provided power is applied to ESS DC bus.

CAUTION: If it is necessary to fire one extinguishant bottle into each engine simultaneously, for example because of a landing emergency, always rotate BOTH fire handles in SAME direction, preferably counterclockwise to "2".

EXTINGUISHING SYSTEMS

APU FIRE EXTINGUISHING SYSTEM

The APU system contains a circuit that will automatically shut down the APU and automatically fire the APU bottle. This circuit is armed by placing the APU fire switch, located on the overhead panel, in the AUTO position. Automatic discharge of the bottle will be indicated by the annunciator showing FIRED.

To manually discharge extinguishant to APU:

APU Fire Handle - PULL. This closes APU LP and HP fuel valves.

After waiting about 10 seconds:

APU Fire Handle - ROTATE (Either Direction). This fires APU bottle and annunciator should show FIRED.

NOTES:

1) Electrical power to fire APU bottle is from the BATT bus.

2) Once bottle is fired, annunciator will continue to show FIRED, provided fire handle is left in "rotated" position.

TEST PROCEDURES

ENGINE FIRE WARNING TEST

Preflight

APU Cockpit Fire Switch - MANUAL.

NOTE: The APU fire warning will not test with fire switch in AUTO.

Fire Bell Cutout - PULL. Bell cutout light should illuminate.

Fire Handle Test Switches (3) - SELECT TO TEST. All three fire handles should illuminate. The fire bell should not sound.

All Test Switches - RELEASE. All fire handle lights should extinguish.

Fire Bell Cutout - DEPRESS. Bell cutout light should extinguish.

Fire Handle Test Switches - SELECT TO TEST (one at a time). The associated fire handle should illuminate and the fire warning bell should sound.

APU Cockpit Fire Switch - AS REQUIRED.

Fire Handles (3) - IN. Assure all three fire handles are IN.

Bottle Fired Indicators (3) - BLANK. Check all three bottle FIRED indicators are blank.

APU FIRE WARNING TEST

Pre-Start and Shutdown

The fire warning will be tested (APU cockpit fire switch in MANUAL) prior to starting and shutting down the APU.

The APU fire switch should ALWAYS be positioned to AUTO when the COCKPIT IS UNATTENDED.

ENGINE OVERHEAT DETECTION TEST

Left and Right Overheat Warning Lights - DEPRESS. They should illuminate and remain illuminated.

Left and Right LP Cooling Switches - Momentarily to RESET. Overheat warning lights should extinguish.

Zone 2 Test Switch - Momentarily to TEST. This will cause both overheat lights to illuminate and extinguish when the test switch is released.

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AIRCRAFT FUEL SYSTEM DESCRIPTION

GENERAL DESCRIPTION

The airplane fuel system, as described in this section, is divided into two sub-systems:

- Fuel Feed and Transfer (including quantity indicating)
- Fueling/Defueling

All fuel is carried in three integral tanks, one in each wing and one in the wing center section. These three tanks provide the following usable fuel capacities:

TANK	USABLE CAPACITY	
	POUNDS (at 6.7 lbs./gal.)	U.S. GALLONS
Left Wing*	9,000	1,343
Right Wing*	8,960	1,337
Center	6,840	1,021
TOTAL	24,800	3,701
*The difference in capacity between wing tanks is due to the space used for the center tank vent line which is routed through the right wing tank.		

A filler cap is provided for each tank to permit overwing fueling, if desired. The filler caps for the wing tanks are about 2/3rds of the way out on each wing. The filler cap for the center tank is inboard on the left wing.

Fuel tank venting is accomplished by a non-icing flush ram air scoop on the underside of each wing near the wing tip. Each scoop is connected into a vent surge tank, formed by wing ribs in the outboard section of the respective wing. Each wing tank vents to its respective surge tank. The center tank vents to the surge tank in the right wing. Fuel that collects in the surge tanks can drain into the adjacent wing tank through a float-operated valve when fuel level in the wing tank reaches a predetermined level. The ram air scoops will provide a slight positive pressure in the vent system at all times in flight.

Supplied by Jeppesen Sanderson

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AIRCRAFT FUEL SYSTEM DESCRIPTION

FUEL FEED & TRANSFER SYSTEM

General Description

Fuel can be fed directly to the engines only from the wing tanks. Fuel from the center tank is transferred into the wing tanks.

Each wing tank incorporates two motor-driven centrifugal type booster pumps to supply fuel under pressure to the engines. The left wing tank also supplies the APU. The pumps are located in the inboard section of each tank, one forward and one aft. The tank is baffled in such a way that fuel in the outboard sections of the tanks can only flow inboard toward the pumps. A check valve is provided at the outlet of each pump to prevent reverse flow through the pump and into the tank when the pump is inoperative. A bypass check valve is provided in the supply line from both pumps to permit the engines to draw fuel directly from the tank when the boost pumps are inoperative.

Fuel from the wing tanks is supplied to the respective engine supply line through an electrically operated valve, called the LP fuel valve. The two engine feed lines are interconnected by a line incorporating another electrically-operated valve, called the crossfeed valve. This arrangement permits each tank to feed its respective engine, or both tanks to feed one engine, or one tank to feed both engines.

The center tank also incorporates two motor-driven centrifugal booster pumps, called transfer pumps, to transfer fuel from the center tank to the wing tanks. At least one transfer pump must be operative to use center tank fuel. A check valve is provided at the outlet of each pump that serves the same purpose as the check valves for the wing tank boost pumps. Incorporated in the check valve is a "rate valve" that limits the rate at which center tank fuel can transfer to the wing tanks. The output of the two transfer pumps is manifolded together and feeds each wing tank through an electrically-controlled, pressure-operated transfer valve. This valve also serves for fueling and defueling of the wing tanks. Center tank fuel enters the wing tanks through a float-operated shutoff valve in each tank that prevents certain compartments in the wing tanks from being over filled.

Fuel quantity indications for each tank are normally provided by a conventional fuel quantity indicator that operates from capacitance-type transmitters. Fuel quantity can also be determined manually on the ground by using a magnetic level indicator MLI. Four MLI's are provided in each wing tank and one MLI in the center tank.

AIRCRAFT FUEL SYSTEM DESCRIPTION

FUEL FEED & TRANSFER SYSTEM (cont'd.)

Controls & Indicators

All controls and indicators, except the fuel quantity indicators, are located on the overhead panel. The quantity indicators are located on the forward center panel.

Booster Pumps Switches

Provide ON/OFF control of respective boost pumps.

Booster Pump LP Lights (2) (Red)

These lights will illuminate if the pressure in the respective engine supply line falls below a normal value. With the crossfeed valve closed, both boost pumps in the respective wing tank must be inoperative before the light will illuminate. With the crossfeed valve open, one operative boost pump in either tank will keep both lights extinguished.

LP Valve Switches & Indicators

Each switch, with OPEN/CLOSE positions, provides control over the low pressure fuel shutoff valve for the respective engine. If the cockpit switch is in the OPEN position and the respective engine fire handle is pulled out, the cockpit switch is overridden and the valve is closed. The magnetic indicator above the switch shows "in-line" when the valve is open, "cross-line" when the valve is closed, and "amber" when there is no power to it.

Engine Low Pressure Lights (Amber)

This light will illuminate when fuel pressure from the respective engine-driven boost pump is below a normal value.

Transfer Pumps Switches

Provide ON/OFF control of the center tank transfer pumps.

Transfer LP Light (Amber)

This light will illuminate when pressure in the transfer manifold is below a normal value and either or both transfer pumps switches are ON.

Transfer Valves Switches & Indicators

Each switch provides control over its respective transfer valve. However, the valve cannot open unless the fueling master switch, at the pressure fueling panel, is OFF. The magnetic indicator above the switch shows the position of the valve, not the switch. It shows "in-line" when the valve is open and "cross-line" when the valve is closed. With the switch in the OPEN position, the indicator shows "cross-line" until such time as fuel pressure from the transfer pumps push the valve open. The indicator will show amber if there is no power from the main DC bus to operate the valve or if the fueling master switch is ON.

Fuel Quantity Indicators (3)

Indicate fuel remaining in each tank in pounds. A test button, adjacent to each indicator, will cause the indicator to run down-scale when it is depressed to indicate that the gauge is operative.

AIRCRAFT FUEL SYSTEM DESCRIPTION

FUEL FEED & TRANSFER SYSTEM (cont'd.)

Operation

Refueling Power Switch Check

If it is desired to determine from the cockpit that refueling power switch is OFF, this can be done at any time by placing the battery switch to OFF and checking battery annunciator. If the annunciator does not move to OFF with the battery switch OFF and the DC hydraulic pump switch OFF, refueling power switch is ON.

Feeding One Wing Tank to Both Engines

If it is desired to feed from one wing tank to the opposite engine with both engines operating, for example, to balance wing fuel load, proceed as follows:

- Turn ON both boost pumps in tank that will supply fuel.

- OPEN crossfeed valve.

- Turn OFF both boost pumps in other wing tank.

Feeding Both Wing Tanks to One Engine (One Engine INOP)

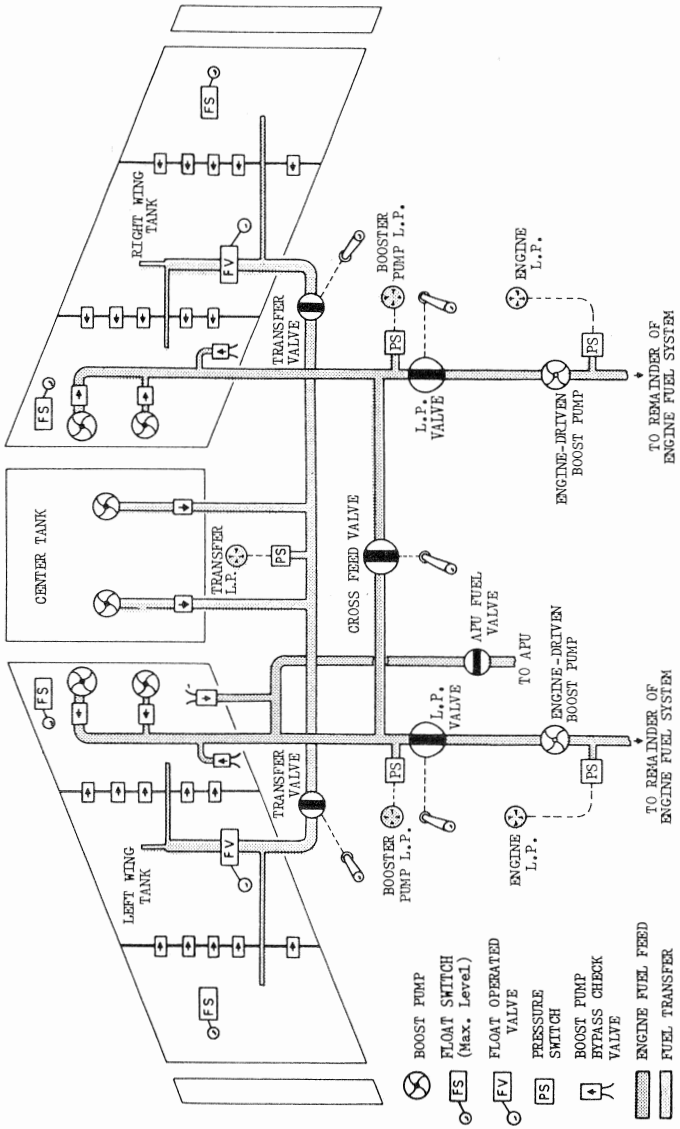
- OPEN crossfeed valve.

- Turn ON one boost pump in each wing tank.

AIRCRAFT FUEL SYSTEM DESCRIPTION

FUEL FEED & TRANSFER SYSTEM
(cont'd.)

Schematic



AIRCRAFT FUEL SYSTEM DESCRIPTION

FUELING/DEFUELING SYSTEM

General Description

Fueling and defueling of the airplane is normally accomplished through a single receptacle located on the lower right side of the fuselage, just under the wing leading edge. Tank filler caps are also provided.

For fueling, fuel under pressure is forced into a manifold that connects to each of the three tanks. The same manifold is used for transferring center tank fuel to the wing tanks during normal operation. Fuel from the manifold enters the tanks through electrically-controlled refueling valves and float-operated shutoff valves. The center tank transfer valves also serve as refueling valves. The float-operated valves in the wing tanks only, automatically shut off fuel flow into certain wing tank compartments when they are full. Float-operated switches in each tank automatically close the refueling valve, stopping fuel flow into the tank when it is full.

Defueling is accomplished by drawing fuel out of the respective tank through the refueling shutoff valve and the same manifold as is used for fueling.

The fueling rate to all tanks is about 3,300 lbs./min. with 50 PSI applied at the fueling nozzle.

Supplied by Jeppesen Sanderson

AIRCRAFT FUEL SYSTEM DESCRIPTION

FUELING/DEFUELING SYSTEM (cont'd.)

Controls & Indicators

All controls and indicators for fueling and defueling are located behind an access door on the lower right side of the fuselage, just forward of the wing leading edge.

Master Switch and Power On Indicator

This switch, with ON/OFF positions, controls all power for fueling and defueling. The green POWER ON indicator light, adjacent to the switch, will be illuminated when the master switch is ON and power is applied to the ESS DC bus. With the master switch ON, power is available to the various refueling and defueling switches. Also, cockpit control of the center tank transfer valves with the transfer valve switches is not possible. Fuel cannot be transferred from the center tank to the wing tanks. The transfer valve annunciator on the overhead panel will illuminate amber. A stop on the fuel panel door prevents closing the door with the master switch ON.

Refuel/Defuel Switch (3)

This three-position switch (REFUEL/OFF/DEFUEL) controls solenoids in the respective refueling valve to determine the mode in which the valve operates, refuel or defuel.

Valve Open Light (3) (Green)

This light illuminates when the respective fueling valve is physically opened by fuel pressure.

Fueling Mode Switch (3)

This is a three-position switch (AUTO/OFF/MANUAL). A guard on the switch prevents moving it to the MANUAL position until the guard is unscrewed from the panel. With the switch in AUTO, control of the respective fueling valve for either refueling or defueling is provided by the tank preselector unit. Fuel flow will cut off automatically at the preselected level. With the switch in MANUAL, control of the fueling valve is from the Refuel/Defuel switch or from the high level float switches in the tank, if the tank is filled during refueling.

Tank Selected Light (3)

This light works in conjunction with the Refuel/Defuel switch and the tank preselector when the Fueling Mode switch is in AUTO. If REFUEL is selected, the light will be illuminated as long as the selected tank quantity is higher than the actual tank quantity. When tank quantity reaches the selected value, the light extinguishes. If DEFUEL is selected, the light will be illuminated as long as the selected tank quantity is lower than the actual tank quantity. When tank quantity reaches the selected value, the light extinguishes.

Tank Preselector (3)

This selector permits selecting a desired tank quantity, in pounds of fuel, for fueling or defueling of the respective tank. It functions only when the Fueling Mode switch for that tank is in AUTO.

AIRCRAFT FUEL SYSTEM DESCRIPTION

FUELING/DEFUELING SYSTEM (cont'd.)

Operation

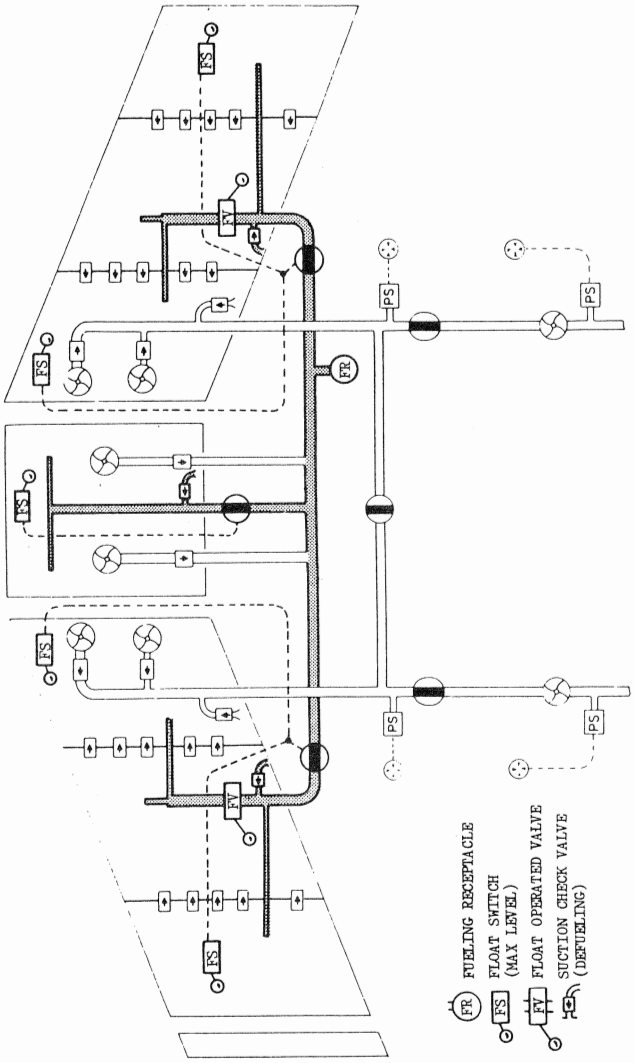
While aircraft refueling is not normally accomplished by the flight crew, it may be necessary for the flight crew to assist in and/or supervise fueling at a station where fueling personnel are not familiar with the airplane refueling system. The fueling procedure is as follows:

- Connect fuel hose nozzle to airplane fueling adapter (on right side of fuselage, below wing leading edge).
- Open fueling panel door (forward of fueling adapter) and position master switch to ON. Check that POWER ON light illuminates.
- Position auto/manual switch for each tank to AUTO and the refuel/defuel switch for each tank to REFUEL.
- Hold warning test light switch, first to the VALVE OPEN position, checking that respective lights for each tank illuminate. Then, return switch to OFF (center) position.
- Set the required fuel quantity for each tank with preselector units. Check that TANK SELECTED lights are illuminated.
- Add fuel until tank selector lights and valve open lights for all tanks extinguish, indicating preselected fuel level has been reached.
- After completing fueling, position all switches, refuel/defuel, auto/manual, and master switch to OFF.

AIRCRAFT FUEL SYSTEM DESCRIPTION

FUELING/DEFUELING SYSTEM
(cont'd.)

Schematic



AIRCRAFT FUEL SYSTEM DESCRIPTION

FUEL LOADING AND USAGE

Loading

Fuel must be loaded in accordance with the following Fuel Distribution Guide, except that a maximum asymmetry between wing tanks of 1,000 lbs. is permitted provided the total quantity required is onboard.

FUEL DISTRIBUTION GUIDE

TOTAL FUEL LOAD (lbs.)	LEFT WING (lbs.)	CENTER TANK (lbs.)	RIGHT WING (lbs.)
5,000	2,500	0	2,500
5,500	2,750	0	2,750
6,000	3,000	0	3,000
6,500	3,250	0	3,250
7,000	3,500	0	3,500
7,500	3,750	0	3,750
8,000	4,000	0	4,000
8,500	4,250	0	4,250
9,000	4,500	0	4,500
9,500	4,750	0	4,750
10,000	5,000	0	5,000
10,500	5,250	0	5,250
11,000	5,500	0	5,500
11,500	5,750	0	5,750
12,000	6,000	0	6,000
12,500	6,250	0	6,250
13,000	6,500	0	6,500
13,500	6,750	0	6,750
14,000	7,000	0	7,000
14,500	7,250	0	7,250
15,000	7,500	0	7,500
15,500	7,750	0	7,750
16,000	8,000	0	8,000
16,500	8,250	0	8,250
17,000	8,500	0	8,500
17,500	8,750	0	8,750
18,500	8,250	2,000	8,250
19,000	8,500	2,000	8,500
19,500	8,750	2,000	8,750
20,000	8,750	2,500	8,750
20,500	8,750	3,000	8,750
21,000	8,750	3,500	8,750
21,500	8,750	4,000	8,750
22,000	8,750	4,500	8,750
22,500	8,750	5,000	8,750
23,000	8,750	5,500	8,750
23,500	8,750	6,000	8,750
24,000	8,750	6,500	8,750
24,500	9,000	6,540	8,960
24,800	9,000 (FULL)	6,840	8,960 (FULL)

Usage

For takeoff, initial climb, and landing, fuel is used from the wing tanks ONLY. The fuel transfer pumps must be OFF and the transfer valves CLOSED. After established in climb, fuel should be transferred from the center tank to the wing tanks.

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AIRCRAFT FUEL SYSTEM DESCRIPTION

LONG RANGE FUEL TANK SUPPLEMENT

General Description

The airplane fuel system is divided into two sub-systems:

- Fuel Feed and Transfer (including quantity indicating)
- Fueling/Defueling

All fuel is carried in three integral tanks, one in each wing and one in the wing center section, plus the three fuselage tanks. These tanks provide the following usable fuel capacities:

TANK	USABLE CAPACITY	
	POUNDS (at 6.7 lbs./gal.)	U.S. GALLONS
Left Wing*	9,000	1,343
Right Wing*	8,960	1,337
Center	6,840	1,021
Middle	2,900	435
Aft	2,100	315
Forward	2,900	435
TOTAL	32,700	4,886
*The difference in capacity between wing tanks is due to the space used for the center tank vent line which is routed through the right wing tank.		

A filler cap is provided for the left wing, right wing, and center tanks only to permit overwing fueling, if desired. The filler caps for the wing tanks are about 2/3rds of the way out on each wing. The filler cap for the center tank is inboard on the left wing.

Fuel tank venting is accomplished by a non-icing flush ram air scoop on the underside of each wing near the wing tip. Each scoop is connected into a vent surge tank, formed by wing ribs in the outboard section of the respective wing. Each wing tank vents to its respective surge tank. The center tank vents to the surge tank in the right wing. Fuel that collects in the surge tanks can drain into the adjacent wing tank through a float-operated valve when fuel level in the wing tank reaches a predetermined level. The ram air scoops will provide a slight positive pressure in the vent system at all times in flight.

AIRCRAFT FUEL SYSTEM DESCRIPTION

LONG RANGE FUEL TANK SUPPLEMENT (cont'd.)

Fuel Loading - Fuselage Tanks

OUTER WING AND CENTER SECTION TANKS MUST BE FULL BEFORE REFUELING FUSELAGE TANKS.

Master Switch (on Main Fueling Panel) - ON.

Outer Wing & Center Section Tank Refuel Valves - CLOSED.

Aft & Forward Fuselage Tank Selector Valves - CLOSED. Hold switches down until amber "Valve in Transit" lights are extinguished.

Center Fuselage Tank Selector Valve - OPEN. "OPEN" indicator green light illuminates.

Forward Fuselage Tank Refuel Valve - OPEN.

CENTER TANK - FILL.

Center Fuselage Tank Selector & Fwd Fuselage Tank Refuel Valve - CLOSED. Hold switch down until amber "Valve in Transit" light extinguished.

Aft Fuselage Tank Selector and Refuel Valve - OPEN. "OPEN" indicator light illuminates.

AFT TANK - FILL.

Aft Fuselage Tank Selector Valve - CLOSED. Hold switch down until amber "Valve in Transit" light extinguished.

Aft Fuselage Tank Refuel Valve - CLOSED.

Forward Fuselage Tank Selector and Refuel Valve - OPEN. "OPEN" indicator light illuminates.

FORWARD TANK - FILL.

Forward Fuselage Tank Selector Valve - CLOSED. Hold switch down until amber "Valve in Transit" light extinguished.

Foward Fuselage Tank Refuel Valve - CLOSED.

Master Switch (on Main Fueling Panel) - OFF.

Auxiliary and Main Fueling Panel Doors - CLOSE & SECURE.

NOTE: Malfunction of all fuel valves must be repaired prior to flight.

AIRCRAFT FUEL SYSTEM DESCRIPTION

LONG RANGE FUEL TANK SUPPLEMENT (cont'd.)

External Checks Before Takeoff

Refueling Station:

Fuselage Tank Refuel Valves - CLOSED.

Fueling Panel Doors - CLOSED & SECURE.

Fuel Tank Drains - NOT LEAKING.

Cockpit Checks Before Takeoff

Fuselage Tank Shutoff Valves - ALL 3 CLOSED.

No Takeoff (Red) Light Extinguished - PRESS-TO-TEST. If red light is illuminated, the forward or aft refuel valve is open and must be closed before takeoff.

Fuselage Tank Quantity Gauges - CHECK QUANTITY.

Fuselage Tank Transfer Pump Pressure Indicator Light - PRESS-TO-TEST.

Center Fuselage Tank Shutoff Valve - OPEN.

No. 1 Forward Fuselage Tank Transfer Pump - ON. Fuel pressure indicator light should illuminate briefly, and then extinguish when pressure builds up. If it does not extinguish, the pump is inoperative.

No. 1 Forward Fuselage Tank Transfer Pump - OFF.

L.H. Outer Wing Tank Transfer Valve - OPEN MOMENTARILY, THEN CLOSED.

No. 2 Forward Fuselage Tank Transfer Pump - ON. Fuel pressure indicator light should illuminate briefly, and then extinguish when pressure builds up. If it does not extinguish, the pump is inoperative.

No. 2 Forward Fuselage Tank Transfer Pump - OFF.

L.H. Outer Wing Tank Transfer Valve - OPEN MOMENTARILY, THEN CLOSED.

Center Fuselage Tank Shutoff Valve - CLOSED.

Aft Fuselage Tank Shutoff Valve - OPEN.

No. 1 Aft Fuselage Tank Transfer Pump - ON. Fuel pressure indicator light should illuminate briefly, and then extinguish when pressure builds up. If it does not extinguish, the pump is inoperative.

No. 1 Aft Fuselage Tank Transfer Pump - OFF.

L.H. Outer Wing Tank Transfer Valve - OPEN MOMENTARILY, THEN CLOSED.

No. 2 Aft Fuselage Tank Transfer Pump - ON. Fuel pressure indicator light should illuminate briefly, and then extinguish when pressure builds up. If it does not extinguish, the pump is inoperative.

No. 2 Aft Fuselage Tank Transfer Pump - OFF.

Fuselage Tank Shutoff Valve - ALL 3 CLOSED.

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AIRCRAFT FUEL SYSTEM DESCRIPTION

LONG RANGE FUEL TANK SUPPLEMENT (cont'd.)

Fuel Transfer

Transfer fuel from fuselage fuel tanks as soon as possible after takeoff.

Transfer fuel from only one tank at a time until tank is empty. Pump low pressure light illuminates when tank is empty.

Select tanks for transfer in the following order: FORWARD, AFT, CENTER. Only one fuselage tank shutoff valve may be open at any time.

Forward Fuselage Tank Shutoff Valve - OPEN.

Outer Wing Tank Transfer Valves - BOTH OPEN OR AS REQUIRED.

Fuselage Tank Forward Transfer Pump(s) - ONE OR BOTH ON. While fuel is being transferred, the fuel pressure indicator light above the fuselage transfer pump switch is extinguished. When the forward fuselage tank is nearly empty, the fuel pressure indicator light will illuminate intermittently. When the tank is empty, the indicator light will illuminate steady.

To insure transferring of maximum fuel from each tank, the airplane should be in level flight when each tank is nearly empty.

UNUSABLE FUEL	LEVEL FLIGHT	IN CLIMB
Foward Tank	20 lbs.	193 lbs.
Aft Tank	23 lbs.	47 lbs.
Center Tank	27 lbs.	73 lbs.

Fuselage Tank Forward Transfer Pumps - OFF.

Forward Fuselage Tank Shutoff Valve - CLOSE.

Aft Fuselage Tank Shutoff Valve - OPEN.

Fuselage Tank Forward Transfer Pump(s) - ONE OR BOTH ON. While fuel is being transferred, the fuel pressure indicator light above the fuselage transfer pump switch is extinguished. When the forward fuselage tank is nearly empty, the fuel pressure indicator light will illuminate intermittently. When the tank is empty, the indicator light will illuminate steady. Refer to the table above to insure transferring of maximum fuel.

Fuselage Tank Transfer Pumps - ALL OFF.

Center Fuselage Tank Shutoff Valve - CLOSE.

Outer Wing Transfer Valves - CLOSE.

Before Landing

Fuselage Tank Shutoff Valves - ALL 3 CLOSED.

Fuselage Tank Transfer Pumps - ALL OFF.

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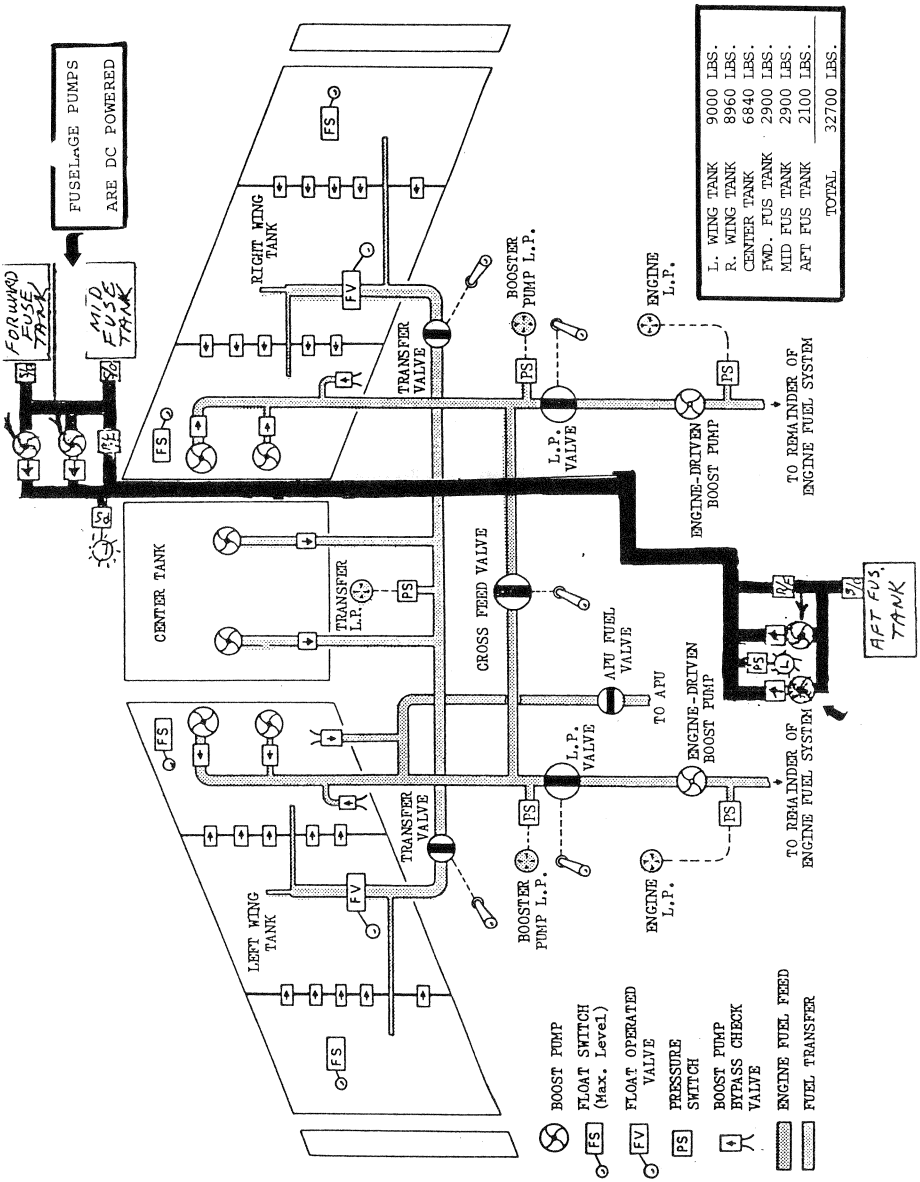
AIRCRAFT FUEL SYSTEM DESCRIPTION

LONG RANGE FUEL TANK SUPPLEMENT
(cont'd.)

Fuel Feed & Transfer System Schematic



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PNEUMATICS SYSTEM DESCRIPTION

GENERAL DESCRIPTION

This section describes only the pneumatic supply system. Systems that are dependent on this pneumatic supply for their operation are covered in their respective systems section in this manual.

Pneumatic air is supplied from the last, 17th-stage, of the compressor in each engine (N2) and from the compressor in the APU. The systems that use this air can be divided into two groups as follows:

- Those that can be supplied only by the respective engine when the engine is operating, and

- Those that can be supplied by either or both engines and the APU.

Those systems or functions that can be supplied only from the respective engine are engine anti-icing, thrust reversing, fuel heating, generator cooling, CSDS speed biasing, and hydraulic reservoir pressurization. Pressurized air is available to these systems any time the respective engine is operating.

Those systems that can be supplied by either or both engines and the APU are air conditioning and pressurization, wing anti-icing, tail anti-icing, and the toilet flush and potable water systems. The supply for these latter systems is from the airplane pneumatic system.

The airplane pneumatic system consists of two parallel ducts, identified as #1 and #2, each connected to the 17th-stage bleed air line from the respective engine. The ducts are joined together by a crossfeed line that incorporates an electrically-controlled, pressure-operated valve called the crossfeed valve. The crossfeed valve permits one engine to supply both pneumatic ducts, if desired. The supply line from the APU is connected into the crossfeed line, on the left side of the crossfeed valve; thus, the #1 duct can be supplied directly from the APU and the #2 duct can be supplied from the APU when the crossfeed valve is open.

Hot, high pressure air from the 17th-stage of each engine compressor (N2) enters the respective pneumatic duct through a shutoff valve called the isolation valve. This valve is electrically-controlled by two solenoids and pneumatically-operated by pressure in the duct. One of the valve solenoids provides for NORMAL RATE opening and closing of the valve from the isolation valve switch in the cockpit or the engine fire handle. The valve closes when the fire handle is pulled, regardless of the position of the isolation valve switch. The other solenoid provides FAST RATE closing of the valve, if the pneumatic system protective circuits are activated.

A pressure reducing valve (PRV) is installed just downstream of the isolation valve in each duct. This valve, like the isolation valve, is electrically-controlled and pneumatically-operated. It incorporates three solenoids to provide its various functions. The valve opens and closes as a function of the isolation valve switch and, when open, it modulates to regulate duct pressure to about 45 PSI. It will close along with the isolation valve, if the pneumatic system protective circuits are activated. If the start master switch is in the START or MOTOR position and one of the start/relight switches are positioned to START & MOTOR, the respective PRV will open fully to permit air from the APU or the ground start connection to flow unrestricted to the CSDS on that engine.

(cont'd.)

PNEUMATICS SYSTEM DESCRIPTION

GENERAL DESCRIPTION (cont'd.)

Downstream of the PRV in each pneumatic duct is a precooler. The precooler uses bleed air from the last, 5th-stage, of the engine low pressure compressor (N1) to cool the 17th stage air through a heat exchanger action. The flow of low pressure bleed air through the precooler is regulated automatically by a temperature control valve that modulates as a function of temperature of the air in the pneumatic duct downstream of the precooler. Low pressure air that passes through the precooler is dumped into the nacelle area and passes overboard around the engine exhaust nozzle. The precooler temperature control valve is closed when both the isolation valve and PRV are closed by the isolation valve switch or protective circuits to prevent low pressure bleed air from being wasted.

The pneumatic system protective circuits prevent damage to the respective pneumatic duct and adjacent airplane structure in the event of overtemperature or overpressure. The protective devices for each pneumatic duct consist of a pressure switch in the duct, set at about ~~67.5~~ 75 PSI; a thermal switch in the duct, set at about ~~220~~ 232°C; and 14 thermal switches in the engine strut around the duct, set at about 120°C. Activation of any of these devices will cause the following to occur:

- Illumination of respective system fail and supplementary trip lights in the cockpit.
- Closure of the isolation valve and the PRV.
- Closure of the precooler temperature control valve.
- An electrical lockout of the system, which prevents the valves from being opened until the fault has been cleared.

Two additional thermal switches, set at about 120°C, are located in the fuselage just forward of the aft cargo compartment where both pneumatic ducts pass through the pressurized area to sense temperature in the area around the ducts. Activation of these thermal switches will cause both system fail lights in the cockpit to illuminate, but the airflow in the pneumatic ducts is not cut off automatically.

Additional duct protective devices are provided in each pneumatic duct to protect the duct against excessive pressure. A relief valve, downstream of the precooler, will normally relieve duct pressure in excess of 55-60 PSI. A blow-out valve, upstream of the precooler, will rupture and dump air overboard if duct pressure exceeds approximately 110 PSI.

A ground start connection is provided in the right #2 pneumatic duct to permit engine starting from a ground cart. Air from the connection is fed directly to the No. 2 engine CSDS. The crossfeed valve must be open to feed this air to the No. 1 engine CSDS.

PNEUMATICS SYSTEM DESCRIPTION

CONTROLS & INDICATORS

All controls and indicators for the pneumatic system are located on the cockpit overhead panel.

Isolation Valve Switches (2)

These two-position switches (OPEN/CLOSE) control operation of the isolation valve, PRV, and precooler temperature control valve in the respective system. When a switch is in the CLOSE position, the respective valves are closed. When a switch is in the OPEN position, the respective valves are open or modulating, except the switch is overridden as follows:

- By the protective circuits for the system, which will close all 3 valves.
- By pulling the fire handle, which closes only the isolation valve.
- By placing the master valve switch to APU, which closes the PRV and the precooler temperature control valve.
- By placing the start master switch to START or MOTOR, which closes only the precooler temperature control valve.

System Fail Lights and Reset Buttons

An amber system fail light and reset button is provided for both pneumatic system #1 and pneumatic system #2. The light will illuminate when the system is deactivated automatically by its protective circuits, e.g., overtemperature in duct or engine strut or overpressure in the duct. The system can be reset and the light extinguished, provided the fault no longer exists, by momentarily depressing the respective reset button. Both system fail lights will illuminate if the fuselage duct thermal switches are activated. The lights will remain illuminated until the temperature falls to a normal value.

Supplementary Pneumatic System Trip Lights

Each pneumatic system has three (3) supplementary trip indicators. These amber lights will help to isolate the area in which a trip has occurred. When a system trip occurs, the system fail light will illuminate and the applicable supplementary trip light, stub duct, duct over temp, or duct over press light will also illuminate indicating the type of trip. In the event of a system trip, should any one of the supplementary lights fail, the system fail light will still illuminate. Should a fuselage duct overtemperature occur, only the two system fail lights will illuminate.

The duct over temp and duct over press lights cannot be tested by the flight crew. The stub duct light will illuminate whenever the Stub Duct Fail Test is made.

Stub Duct Fail Test Buttons (2)

These buttons permit checking the respective pneumatic system protective circuits. When a button is depressed, the respective system fail and stub duct lights should illuminate, indicating proper operation of the protective circuits. The lights will remain illuminated until the reset button is depressed.

(cont'd.)

PNEUMATICS SYSTEM DESCRIPTION

CONTROLS & INDICATORS (cont'd.)

Fuselage Duct Fail Test Button

This button permits checking the fuselage duct overheat circuits. When the button is depressed, both system fail lights should illuminate, indicating proper circuit operation. Both lights should extinguish when the button is released.

Pneumatic Pressure Indicator

This dual indicator, labeled MAINS, indicates pressure in the respective pneumatic supply duct. Pressure in each duct is sensed just downstream of the precooler.

Air Temperature Selector Switch

This switch is installed on the Anti-Ice Control Panel to permit reading the pneumatic systems temperatures on the wing and tail anti-ice temperature gauge. This three-position switch (WING/TAIL/MAINS 1 & 2) is located just to the right of the temperature gauge.

Normally, the switch should remain in the MAINS 1 & 2 position. In this position No. 1 mains temperature is indicated on the WING side and No. 2 mains temperature on the TAIL side of the gauge. When wing and tail anti-icing is used, their temperatures should be checked occasionally by positioning the switch to WING and/or TAIL.

Supplied by Jeppesen Sanderson

PNEUMATICS SYSTEM DESCRIPTION

PNEUMATIC SUPPLY SYSTEM - NORMAL OPERATION

NOTE: This section covers only the basic pneumatic supply system. For operation of other systems that use this pneumatic supply, e.g., air conditioning, anti-icing, starting, etc., refer to the specific system section in this manual.

Isolation Valve Switch - OPEN. This switch must be in the OPEN position to get a supply of bleed air from the respective engine into its pneumatic supply duct. This opens the isolation valve, the pressure regulating valve (PRV), and the precooler temperature control valve.

If the master valve switch is in the APU position with the isolation valve switch in the OPEN position, the circuit to the PRV and temperature control valve is overridden and these valves are closed. This is done to shut off all bleed from respective engine with the isolation valve switch in the OPEN position, while APU bleed is supplying system.

Air Crossfeed Valve Switch - OPEN. This switch is placed to the OPEN position when it is desired to feed bleed air from one engine to the opposite pneumatic supply duct. The valve must also be OPEN to supply the right (No. 2 engine) pneumatic duct from the APU.

FUSELAGE DUCT FAIL TEST

Fuselage Duct Fail Test Pushbutton - DEPRESS. If the fuselage overheat thermostats are serviceable (closed), both system fail lights should illuminate.

Fuselage Duct Fail Test Pushbutton - RELEASE. Both system fail lights should extinguish.

STUB DUCT FAIL TEST

Left or Right Stub Duct Fail Test Pushbutton - DEPRESS. If the stub duct (bay) thermostats on that side are serviceable (closed), the respective system fail and stub duct lights should illuminate.

Left or Right Stub Duct Fail Test Pushbutton - RELEASE. The lights should remain illuminated.

System Fail Press-to-Reset Pushbutton - DEPRESS. The lights should extinguish.

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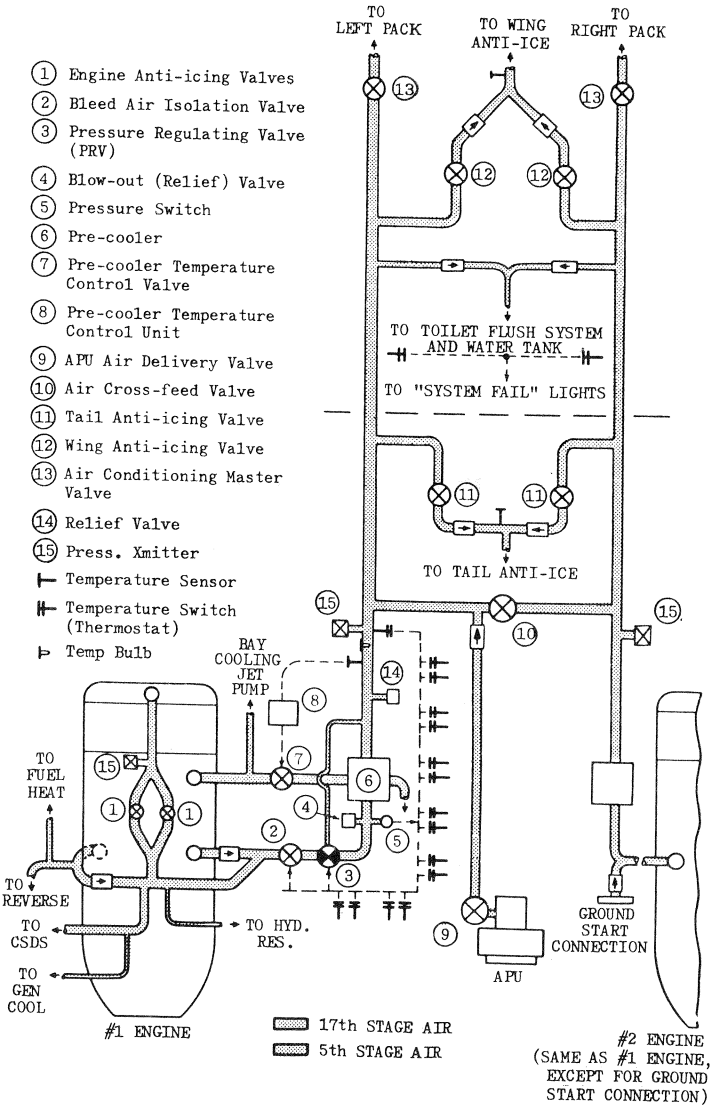
PNEUMATICS SYSTEM DESCRIPTION

SCHEMATIC



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AIR CONDITIONING SYSTEM DESCRIPTION

GENERAL DESCRIPTION

The air conditioning and pressurization systems provide ventilation, controlled temperature, and regulated air pressure for the cabin and cockpit. The cargo compartments are pressurized to the same differential pressure as the cabin and cockpit, but have a low ventilation rate so as not to sustain combustion.

The air conditioning system consists essentially of two independent air conditioning packs, their associated valves and controls, and the distribution ducting.

Each air conditioning pack consists of a conventional air cycle machine (ACM), two heat exchangers (a primary and a secondary), and a water separator. High pressure bleed air is supplied to each pack from the respective main pneumatic duct through a combination airflow control and a shutoff valve, called a master valve. An air mixing valve for each pack determines whether hot air from the supply duct is directed through the pack or around it. This establishes the desired temperature in the distribution ducting.

Ambient air is used to cool pneumatic system air passing through the pack heat exchangers. In flight, with the landing gear retracted and the airspeed above about 165 KIAS, ram air alone provides heat exchanger cooling. This ram air is picked up at two scoops on the underside of the fuselage. It passes through the respective heat exchangers and is dumped overboard through a vent at the aft end of the air duct. The overboard vent from each cooling air duct incorporates a two-position, pneumatically-operated shutter to control the exit airflow and thus, the airplane drag generated by the cooling ducts. The shutters reduce the exit area from each duct by about 2/3rds when airspeed is above 220 KIAS.

On the ground, the cooling airflow to the heat exchangers in both packs is supplied by a single AC motor-driven blower. The blower and both ACM's can be turned off ON THE GROUND ONLY, through a ground cooling fan (ON/OFF) switch located adjacent to the ACM inlet-outlet temperature gauge. With the airplane on the ground and this switch ON, the blower will operate at all times as long as there is power to the No. 1 AC bus and the Main DC bus.

This blower also operates in flight, when the landing gear is DOWN and the airspeed is below about 165 KIAS, to augment ram airflow through the heat exchangers. The ground cooling fan switch must be ON for blower operation below 165 KIAS.

A water separator is provided for each ACM to automatically extract moisture from the cold air leaving the ACM. An anti-icing control valve is provided for each water separator to automatically prevent icing of the separator. This is done by admitting warm air to the separator as needed.

(cont'd.)

AIR CONDITIONING SYSTEM DESCRIPTION

GENERAL DESCRIPTION (cont'd.)

Each pack master valve is electrically controlled and pneumatically operated. A solenoid in the valve must be energized for the valve to open. When the solenoid is energized, the valve modulates as required to maintain an airflow to the respective pack of about 50-55 lbs./min. To protect the pack and ducting, the master valve for each pack is closed automatically, along with certain other valves in the pneumatic system, if ACM compressor discharge temperature exceeds about 185°C or distribution duct temperatures exceeds about 70°C.

The air mixing valve for each pack is driven open (warmer) or closed (cooler) by an AC motor. The motor is controlled by the automatic temperature control circuits or from a manual temperature control switch in the cockpit. If the temperature in the distribution duct exceeds about 60°C, the mixing valve is automatically driven toward the closed (cooler) position.

Ram air can be admitted to the cabin and cockpit for unpressurized ventilation when desired. This air is taken from the right ram air duct. It passes through a motor-operated shutoff valve and enters the air distribution ducting just downstream of the right air conditioning pack.

AIR CONDITIONING SYSTEM DESCRIPTION

AIRFLOW

Cabin

Conditioned air is supplied to the cabin through a sidewall distribution system. Air from both packs passes into longitudinal ducts along both sides of the fuselage. From the longitudinal ducts, the air enters risers that pass around the cabin windows. It enters the cabin through slots under the hat racks. Air leaves the cabin through a series of holes in the sidewall, just above floor lever. It flows around the cargo compartment and forward to the single outflow valve on the left side of the forward fuselage.

Cockpit

Conditioned air is supplied to the cockpit from the No. 1 system air mixing duct, through a restrictor that limits cockpit airflow to about 15% of air available from the No. 1 system. Air enters the cockpit through two outlets forward of the rudder pedals, an outlet at the bottom of each console (sidewall), and an outlet in the cockpit ceiling. The airflow through the ceiling outlet can be adjusted by a knob on the ceiling just aft of the outlet. Air leaves the cockpit primarily through the radio rack and passes overboard through the outflow valve.

"Eyeball" System

Adjustment "eyeball" type cold air outlets are provided at each passenger service unit, in the cockpit, galley, and in each lavatory. Air is supplied to these outlets from the cold air discharge line of both air conditioning packs.

Supplied by Jeppesen Sanderson

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AIR CONDITIONING SYSTEM DESCRIPTION

CONTROLS & INDICATORS

All controls and indicators for the air conditioning system are located on the cockpit overhead panel, except the air cycle machine temperature indicator and selector which is located on the aft cockpit bulkhead behind the Captain's seat and the ram air valve switch which is located on the forward instrument panel.

Master Valve Selectors (2)

These three-position rotary selector switches provide the following functions:

OPEN -- The respective master valve is energized and modulates to regulate airflow to its pack.

APU --- The respective master valve is energized as in the OPEN position, and in addition, the respective pneumatic system pressure regulating valve (PRV) is closed to stop airflow from the respective engine.

CLOSE - The respective master valve is de-energized and closed.

Master Valve Lights (Amber) (2)

This amber light will illuminate if the respective system's temperature protection circuit is activated, ACM compressor discharge temperature above 185°C or distribution duct temperature above 70°C. The system fail light for the respective system will illuminate at the same time. Action of this circuit causes closure of the master valve, isolation valve, and PRV in the respective system, and the air crossfeed valve; additionally, the APU air delivery valve, if system No. 1.

These valves will remain closed and the lights will remain illuminated until the master valve selector is placed in the CLOSE position and the temperatures are below the trip value. At this time, both lights will extinguish. It is not necessary to actuate the system fail reset switch to extinguish the system fail light.

Temperature Control Switches (2)

These switches have AUTO/DEC/INC positions. The center (unmarked) position is OFF. When a switch is in AUTO, the respective pack mixing valve is positioned by the automatic temperature control system, the desired temperature being established by the temperature selector forward of the temperature control switch.

When a switch is held in the momentary INC or DEC position, the respective mixing valve is controlled directly to establish the desired temperature. The mixing valve remains in the selected position when the switch is released.

Temperature Selectors

These rotary selectors establish the desired temperature for automatic regulation when the respective temperature control switch is in AUTO. Temperatures between 65°F and 85°F can be established.

Mixing Valve Position Indicators

These indicators show position of the respective mixing valve.

(cont'd.)

AIR CONDITIONING SYSTEM DESCRIPTION

CONTROLS & INDICATORS (cont'd.)

Cabin Temperature Indicator

This indicator shows temperature of air at about mid-point of cabin.

Dual Air Inlet Temperature Indicator

This indicator shows temperature of air in the supply duct from the respective pack.

Air Cycle Inlet/Outlet Temperature Indicator and Selector

This dual indicator shows temperature at the compressor inlet and turbine outlet of the selected air cycle machine. The two-position selector below the indicator permits selecting the air cycle machine in either system No. 1 (cockpit) or system No. 2 (cabin). This indicator is intended primarily for use in system trouble shooting.

Ram Air Valve Switch

This two-position switch (OPEN/CLOSE) provides direct control over the ram air valve. When the switch is in the OPEN position, ram air is admitted to the air conditioning distribution ducts from the right ram air duct (pack heat exchanger duct).

AIR CONDITIONING SYSTEM DESCRIPTION

AIR CONDITIONIONG SYSTEM - NORMAL OPERATION

Control switch settings and checks during specific phases of operation are detailed in Chapter 3 - NORMAL OPERATING PROCEDURES of this manual.

Normal operation of the system requires only that basic pneumatic source be supplied to the respective air conditioning pack as follows:

To Supply Pack from Respective Engine

- Air Crossfeed Valve - CLOSED
- APU Air Delivery Valve - CLOSED
- Isolation Valve - OPEN
- Master Valve Selector - OPEN

To Supply Both Packs from One Engine

- Air Crossfeed Valve - OPEN
- APU Air Delivery Valve - CLOSED
- Desired Isolation Valve - OPEN
- Both Master Valve Selectors - OPEN

To Supply Both Packs from the APU

- Air Crossfeed Valve - OPEN
- APU Air Delivery Valve - OPEN
- Isolation Valves - OPEN
- Both Master Valve Selectors - APU

NOTES:

1) When the APU is INOP, a ground air source (start cart) may be used for ground operation of the air conditioning system, in which case, the right master valve must be positioned to OPEN.

2) During warm weather ground operations, it is recommended that only one air conditioning pack be operated by the APU. This will reduce APU EGT and provide greater airflow to the operating pack.

3) With only one air conditioning pack operating, operations above 25,000 feet are not permitted.

4) With only one air system operating, APU and one air system inoperative, operations above 25,000 feet are not permitted.

5) The maximum altitude at which the APU may be used to supply the air system is 17,000 feet.

6) Refer to Chapter 2 - LIMITATIONS for additional APU limits.

(cont'd.)

AIR CONDITIONING SYSTEM DESCRIPTION

AIR CONDITIONIONG SYSTEM - NORMAL OPERATION (cont'd.)

Automatic Temperature Control (Normal Method)

Set the temperature mode selector to the AUTO position. Rotate the temperature selector to obtain the desired temperature. The temperature will be maintained automatically at the selected value.

NOTE: With a "cold-soaked" airplane and, in some cases, moderate to extreme cold temperatures, it may be necessary to leave the temperature mode selectors in MANUAL and utilize the alternate temperature control method described later until cockpit/cabin airflow/temperatures stabilize after takeoff. This is especially true with the cockpit temperature selector.

Do not position either temperature mode selector to AUTO or allow it to remain in AUTO without airflow to the associated air conditioning pack. Without airflow and the mode selector in AUTO, the associated air mix valve has a tendency to travel toward full OPEN. When airflow is reinduced, this will normally cause an air conditioning trip.

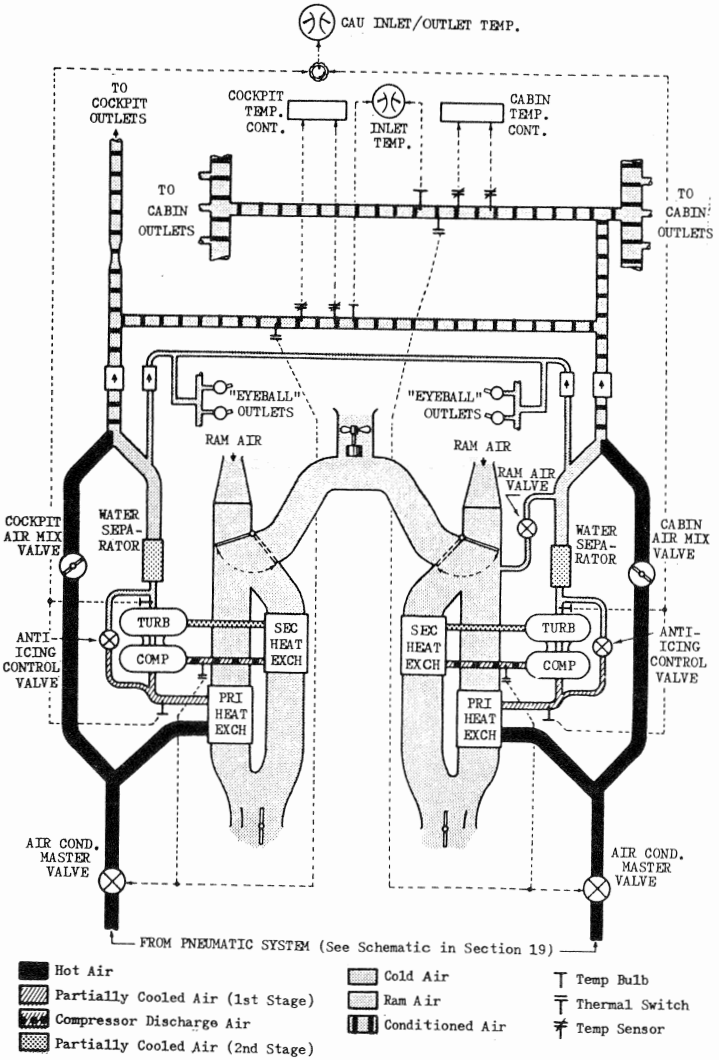
The temperature mode selectors, as outlined in Chapter 3 - NORMAL OPERATING PROCEDURES of this manual, are normally positioned to OFF after landing and left in OFF until after engine start.

Manual Temperature Control (Alternate Method)

Move the temperature mode selector to the momentary INC or DEC position to obtain desired results. When the switch is released, the temperature control valve will stay in the last selected position.

AIR CONDITIONING SYSTEM DESCRIPTION

SCHEMATIC



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PRESSURIZATION SYSTEM DESCRIPTION

GENERAL DESCRIPTION

The entire fuselage, except the radome, gear wells, center section torque box, and tail section, is pressurized. Pressurization is established by controlling the rate at which conditioned air from the pneumatic system is permitted to leave the airplane through a single outflow valve. The outflow valve, located on the lower left side of the nose section, is controlled electro-pneumatically for normal operation, or manually when the normal system is inoperative.

Electro-pneumatic control (normal operation) of the outflow valve is provided by the automatic cabin pressure controller in the cockpit through an electronic amplifier located in the radio rack. Electrical power must be available from the No. 1 AC bus in order to have normal pressurization control. The automatic system can provide a maximum differential pressure of 8.2 PSI. The outflow valve incorporates an emergency pressure controller that prevents cabin altitude from exceeding 9,000 feet, if the automatic pressure control system should fail.

A safety valve is located adjacent to the outflow valve. This valve will open if cabin pressure exceeds ambient pressure by more than 8.75 $\pm$.05 PSI or if ambient pressure exceeds cabin pressure by more than .5 PSI.

NOTE: Unmodified aircraft limited to 35,000 feet have a normal maximum differential pressure of 7.5 PSI and safety valve at 8.0 PSI.

A suction pump operates in conjunction with the outflow valve and the safety valve. The pump operates whenever cabin differential pressure is below approximately 1 PSI and power is available from the No. 1 AC bus. The pump will cut out automatically when pressure is above 1 PSI. The pump serves to smooth operation of the outflow valve to reduce pressure bumps. It also serves to pull the safety valve open when desired on the ground, to avoid cabin pressure surges caused by the opening and closing of cabin doors.

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PRESSURIZATION SYSTEM DESCRIPTION

CONTROLS & INDICATORS

Automatic Pressure Controller

This controller, located on the forward instrument panel, controls the outflow valve through the pressurization system (electronic) amplifier. The controller has three separate control knobs that function as follows:

- Barometric Correction Knob - This knob, at the 6 o'clock position, is used to set the reference barometric pressure for the controller. The knob moves a pointer along a scale in the upper segment of the controller face. The pointer is set to 29.92 for all normal operations.

- Cabin Altitude Knob - This knob, inscribed with the letter "A", moves a scale that is used to select the desired cabin altitude. The cabin altitude scale, just below the barometric correction scale, is read against the barometric correction pointer. A DIFFERENTIAL PRESSURE GRAPH presenting CABIN ALTITUDE VS. AIRPLANE ALTITUDE is detailed in this chapter.

- Rate Knob - This knob, inscribed with the letter "R", is used to select the rate of cabin pressure change. Rotating the knob from stop-to-stop will produce rates from 150 FPM to 1,000 FPM. When the white dot on the knob is in the vertical position, the rate of change will be about 400 FPM.

Cabin Altitude/Differential Pressure Indicator

This combination indicator shows Cabin Altitude (inner scale) and Cabin Differential Pressure (on the outer scale).

Cabin Vertical Speed Indicator

This indicator shows the rate of cabin pressure change in terms of FPM.

Cabin Altitude Warning Light

This amber light will illuminate and an interrupted horn will sound if cabin altitude exceeds 10,000 feet. Pushing the light cap will silence the horn. After a warning is cancelled, the circuit is rearmed when cabin altitude becomes less than 10,000 feet.

Safety Valve Switch

This two-position switch (OPEN/CLOSE) is located adjacent to the ram air switch. When the switch is in the OPEN position on-the-ground, the safey valve will open due to the action of the suction pump described earlier. If the switch is placed in the OPEN position in flight, the safety valve may open a small amount and will probably cause sluggish operation of the normal pressurization controls; therefore, the switch should be in the CLOSE position at all times in flight. When the switch is moved from OPEN to CLOSE on-the-ground, it takes approximately one (1) minute for the safety valve to actually close.

(cont'd.)

PRESSURIZATION SYSTEM DESCRIPTION

CONTROLS & INDICATORS (cont'd.)

Air Dump Valve Knob

This red knob, located on the right console, permits manual operation of the outflow valve when the automatic system is inoperative. The knob must be depressed to engage a gear train that operates the mechanical linkage to the outflow valve. Once depressed, the knob is turned clockwise to open the outflow valve (decrease pressure) and counterclockwise to close the outflow valve (increase pressure). If through some malfunction the automatic system is calling for the outflow valve to open, the manual control will not close the valve due to the design of the valve linkage.

Discharge (Outflow) Valve Position Indicator

This indicator, located adjacent to the air dump valve knob on the right console, indicates the position of the outflow valve.

Pressurization/Flight Altitude Data Plate (if so equipped)

Forward of the throttle quadrant is a Data Plate outlining the pressure controller setting in relation to a flight altitude. In normal operations, the Data Plate is used to set the pressure controller but, in no case will the controller normally be set to less than 500 feet above field pressure altitude, except for landing.

The Data Plate will establish cabin altitudes available at normal maximum pressure differential of 8.2 PSI from sea level to 35,000 feet. This will prevent pressure instability that may occur if the pressure controller is permitted to work at its normal limit.

This will also keep the number of cabin pressure cycles above 7.5 PSI to a minimum while still providing an acceptable cabin altitude.

From 35,000 feet to 39,000 feet, the pressure controller is set at 8,500 feet cabin altitude. This will cause pressure differential to increase as flight altitude increases, allowing cabin altitude to remain somewhat fixed.

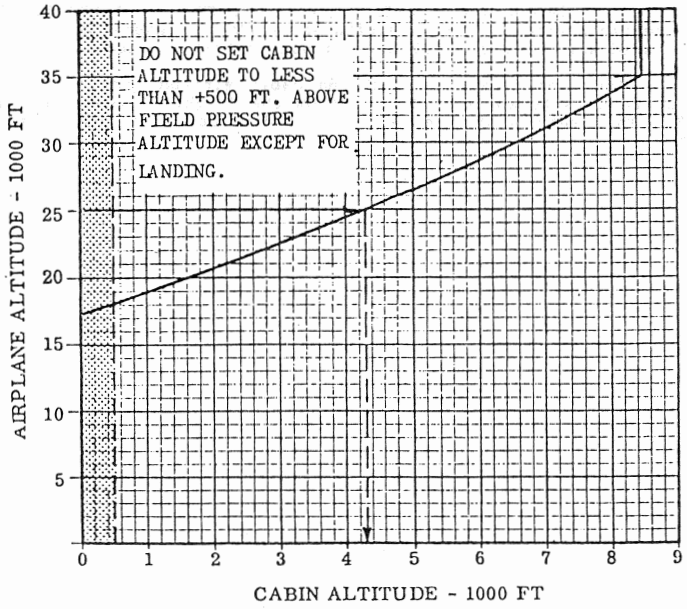
(cont'd.)

PRESSURIZATION SYSTEM DESCRIPTION

CONTROLS & INDICATORS (cont'd.)

Pressurization/Flight Altitude Data Plate (if so equipped), (cont'd.)

The following graph represents the Cockpit Pressure Data Plate. It may also be helpful in the unlikely event that the Data Plate would be missing from the cockpit.



NOTES:

1) Use this graph to determine required cabin altitude setting for desired airplane flight altitude. If computed cabin altitude is 500 feet or less than departure airport pressure altitude, set controller to 500 feet above departure airport pressure altitude. On short legs, when going from a comparatively low altitude airport (MSL) to a higher altitude airport, consideration should be given to setting the controller to the arrival airport's pressure altitude.

2) The graph will establish cabin altitude about 2,100 feet above that actually available at normal maximum pressure differential of 8.2 PSI. This will prevent pressure instability that may occur if pressure controller is permitted to work at it normal limit and to limit number of cabin pressure cycles above approximately 7.5 PSI.

(cont'd.)

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PRESSURIZATION SYSTEM DESCRIPTION

CONTROLS & INDICATORS (cont'd.)

Pressurization/Flight Altitude Data Plate (cont'd.)

NOTES: (cont'd.)

3) This graph will provide for fixed cabin altitude of 8,500 feet at flight altitudes of 35,000 feet and above.

4) For somewhat higher or lower cabin altitudes and corresponding pressure differentials, refer to DIFFERENTIAL PRESSURE GRAPH representing varying cabin altitudes and/or pressure differentials associated with selected flight altitude in this chapter.

5) A quick "rule of thumb" for setting cabin altitude for flight above 17,000 feet is to subtract 17,000 from the flight altitude and divide by 2. This setting can be refined, if desired, after established in climb.

PRESSURIZATION SYSTEM DESCRIPTION

PRESSURIZATION SYSTEM - NORMAL OPERATION

Control switch settings to establish required pressurization air source for any specific phases of operation are detailed in Chapter 3 - NORMAL OPERATING PROCEDURES.

Before Starting Engines

Air Dump Valve - CLOSED

Ram Air Valve - CLOSED

Safety Valve - OPEN

Pressurization Controller - SET, as follows:

- Set Barometric Correction knob to 29.92. Since there is no index on scale for 29.92, set it a "hair" below 30.
- Set Rate Knob to put dot in 12 o'clock position.
- Set Cabin Altitude knob to value required by desired cruising altitude, but not less than 500 feet above field pressure altitude.

Before Takeoff

Safety Valve - CLOSED.

Perform "static check" on the first flight of the day for airplane or when static system maintenance has been performed.

Climb to Cruising Altitude

Check and if not previously set, set cabin altitude to value required by desired cruising altitude, but not less than 500 feet above field pressure altitude.

Enroute Climb

Before starting climb, reset cabin altitude to value required by new cruising altitude.

Adjust rate knob so as to establish cabin rate of climb of about 500 FPM.

Descent

Set cabin altitude to 500 feet above published field elevation.

Set rate knob to establish cabin rate of descent, not to exceed 300 FPM.

Before Landing

Reset cabin altitude to field pressure altitude. Obtain field pressure altitude by converting field altimeter setting to field pressure altitude.

After Landing

Safety Valve - OPEN.

"Snub" rate and select a slightly higher cabin altitude to assure discharge valve opens and in preparation of "zeroing" the mains.

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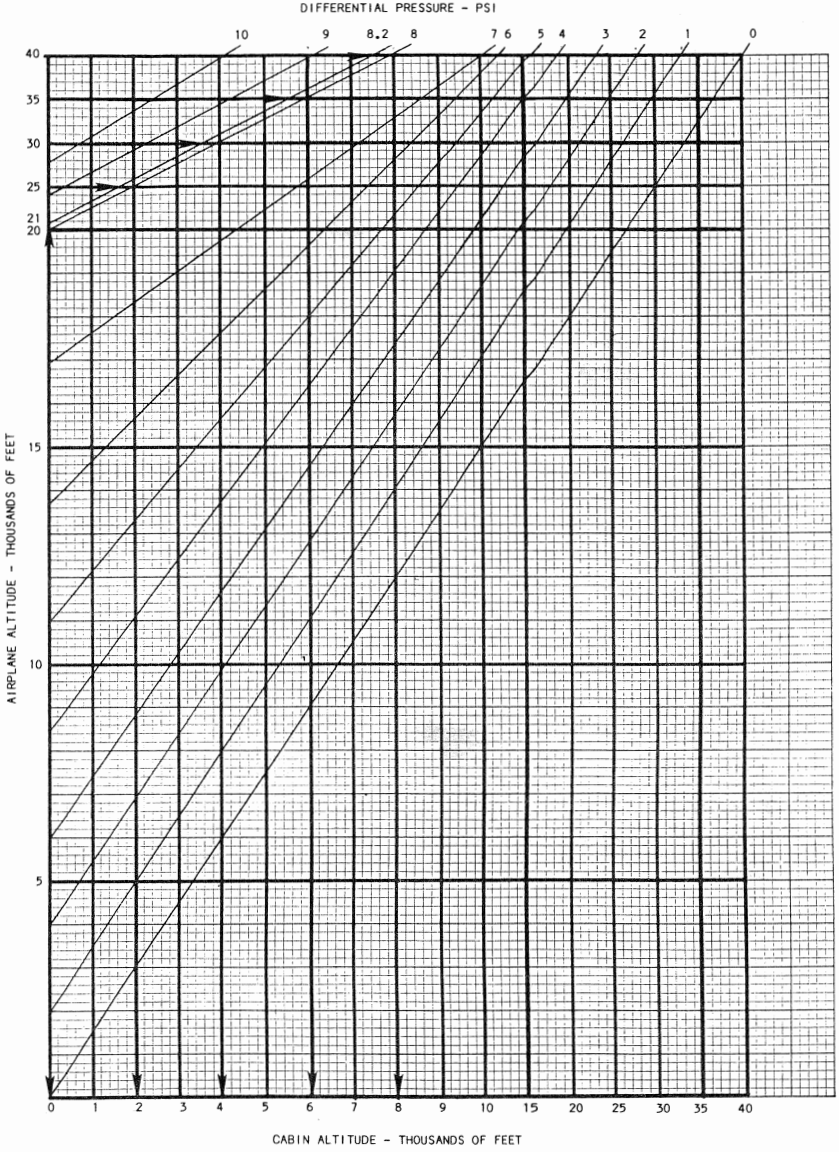
PRESSURIZATION SYSTEM DESCRIPTION

PRESSURIZATION SYSTEM - NORMAL OPERATION (cont'd.)

Differential Pressure Graph

The following graph presents varying cabin altitudes and/or pressure differentials associated with selected flight altitude.



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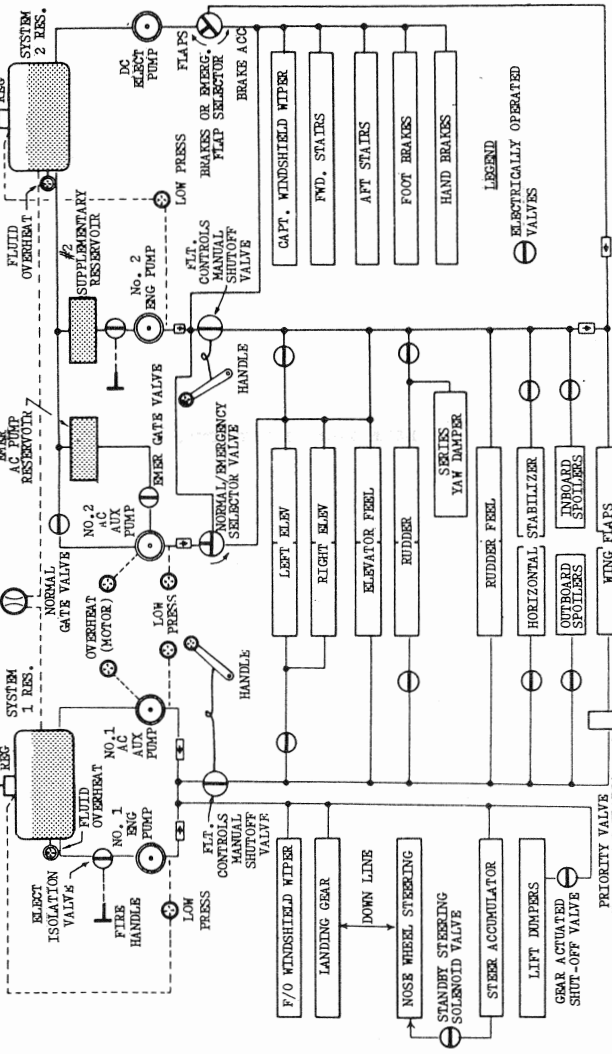
HYDRAULIC SYSTEM DESCRIPTION

GENERAL ARRANGEMENT/FUNCTIONAL SCHEMATIC

(Valves in Normal Position - Inflight)



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HYDRAULIC SYSTEM DESCRIPTION

GENERAL DESCRIPTION

Hydraulic power for various services throughout the airplane is provided by two completely independent systems, referred to as system No. 1 and system No. 2. The specific services powered by each system are shown on the HYDRAULIC SYSTEM GENERAL ARRANGEMENT DIAGRAM in this chapter.

Each system contains the necessary reservoirs, pumps, valves, etc., to provide the required functions. A large number of these components are located at the aft end of the main gear wheel well, system No. 1 components on the left and system No. 2 components on the right. Both systems use Skydrol 500B hydraulic fluid and operate at a nominal pressure of 3,000 PSI. Major components are described in this chapter.

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HYDRAULIC SYSTEM DESCRIPTION

MAJOR COMPONENTS

Reservoirs

Each system incorporates a main reservoir to provide the required fluid supply. The No. 1 main reservoir stores about 2.6 gallons of fluid; the No. 2 main reservoir stores about 3.0 gallons. Each is pressurized with air supplied from the N2 compressor of the respective engine through a regulating valve that automatically maintains the proper reservoir pressure. The main reservoirs, which are located in the main gear well, are serviced through conventional filler caps.

In addition to its main reservoir, system No. 2 incorporates two additional smaller reservoirs, each storing about a gallon of fluid. One of these reservoirs, referred to as No. 2 supplementary reservoir, is installed to handle the additional fluid in the No. 2 system when the brake accumulators are discharged (flat). The other reservoir, referred to as the emergency AC pump reservoir, is installed to supply the No. 2 auxiliary pump when it is used as an emergency source of pressure for the elevator system. Both of these reservoirs are serviced through and pressurized by the No. 2 main reservoir.

Pumps

Each system incorporates two variable displacement pumps, one engine-driven and one driven by an AC electric motor. The AC motor-driven pumps are referred to as auxiliary pumps. The engine-driven pumps are mounted on the N2 gearbox of the respective engine and have an output capability of about 22 GPM. The AC pumps, with an output capability of about 6.0 GPM, are located in the main gear well.

Either the engine-driven pump or the auxiliary pump will supply pressure to its respective system. The engine pumps supply pressure for all normal inflight operations and the auxiliary pumps are used as an alternate pressure source inflight and a primary pressure source on the ground with engines not running. The No. 2 auxiliary pump also serves as an emergency pump for the elevator system when required.

An additional pump, driven by a DC motor, is installed in the No. 2 system. This pump, with an output capability of about 1/3 GPM, is located in the main gear well. It draws its fluid from the No. 2 reservoir and supplies certain No. 2 system functions when required. (See GENERAL ARRANGEMENT DIAGRAM in this chapter.)

Engine Pump Electric Isolation Valves

An electrically-operated isolation valve is provided for each engine pump to permit shutting off the fluid supply from the reservoir to the pump. The valve is closed by pulling the respective engine fire handle. Electrical power is from the ESS DC bus through individual C/B's: system No. 1 #194, system No. 2 #197, Panel B-4.

Priority Valve

This valve, installed only in system No. 1, automatically gives priority to the landing gear over the flaps when both are actuated simultaneously. It assures that the flap system will not starve the gear system.

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HYDRAULIC SYSTEM DESCRIPTION

MAJOR COMPONENTS (cont'd.)

Flight Control Manual Shutoff Valves

These valves are operated by the flight control cutoff levers in the cockpit and permit shutting off all pressure to the flight controls powered by the respective system in the event of a malfunction.

Selector Valves

Two electrically operated selector valves are provided in system No. 2. One valve controls the output of No. 2 auxiliary pump to determine whether its pressure is used for normal or emergency operation. The other valve controls output of the DC pump to determine whether its pressure is used for brakes, Captain's windshield wipers, flap system, or front or rear stairs.

HYDRAULIC SYSTEM DESCRIPTION

OPERATION

Normal switch settings and other checks for specific phases of operation are detailed in Chapter 3 - NORMAL OPERATING PROCEDURES of this manual. Hydraulic power pertaining to flight controls is detailed in Chapter 12 - FLIGHT CONTROLS of this manual.

Both engine pumps are normally left ON for all operation. The auxiliary AC electric pumps are used for ground checks with engines inoperative and in place of an engine pump in the event of engine or engine pump failure. In addition, the No. 1 auxiliary pump must be ON for takeoff and landing to serve as a backup to the No. 1 engine pump and provide pressure for gear retraction in event of failure of the engine or engine pump. The No. 2 auxiliary pump is also used as an emergency source of pressure for the elevator system. The DC electric pump is used only when the No. 2 engine and auxiliary pumps are inoperative. Refer to GENERAL ARRANGEMENT/FUNCTIONAL SCHEMATIC in this chapter.

When both the No. 1 and No. 2 auxiliary hydraulic pumps are required, turn them on separately, pausing a few seconds before energizing the second pump. Failure to pause momentarily before turning on the second pump may overload and trip the split system breaker if it is closed.

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HYDRAULIC SYSTEM DESCRIPTION

CONTROLS & INDICATORS

Location

All hydraulic power system controls and indicators are located on the forward center instrument panel, except the flight control cutoff levers and emergency elevator controls which are on the pedestal.

Hydraulic Quantity Indicator

This dual indicator shows the quantity of fluid contained in system No. 1 and No. 2 main reservoirs. Each scale has green, yellow, and red range markings to show normal, cautionary, and low fluid levels respectively.

Aux Pump Overheat Lights (2)

These amber lights indicate an overheat of the AC motor that drives the respective auxiliary hydraulic pump. Following an overheat, the light will remain illuminated with the pump switch ON until the motor cools down. The pump will continue to run as long as the switch is ON, barring a motor seizure. However, the light will extinguish if the pump is turned OFF, but this does not reset the thermal switch in the pump motor. The light will again illuminate if the pump is subsequently selected ON and the motor's thermal switch has not cooled down. It is possible to operate the pump with the overheat light illuminated.

(System) Overheat Lights (2)

Illumination of one of these amber lights indicates an overheat of fluid in the respective main reservoir. The light will extinguish automatically when fluid temperature returns to normal.

Engine Pump Switches (2)

Each switch controls the depressurizing valve in its respective engine-driven pump. With the switch OFF, the valve is energized and the output pressure of the pump falls to zero; rotation of the pump, however, is not stopped.

Aux Pump Switches (2)

These switches control operation of the AC motor that drives the respective auxiliary pump. Turning on the No. 2 auxiliary pump inflight will prevent operation of the air conditioning system ground blower through the automatic load shedding circuits. Turning on both auxiliary pumps with only one generator operative (ground or flight) will automatically cut off galley power.

Fail Lights (4)

An amber fail light is provided for each engine-driven and auxiliary pump. The light illuminates whenever pump output pressure falls below a predetermined value. In addition, the engine pump light will illuminate when air pressure in the respective reservoir is below the normal value, since fluid under pressure is required at the engine pumps to prevent pump cavitation and damage.

Hydraulic Pressure Indicator

This dual indicator provides a reading of the actual pressure in the respective system.

HYDRAULIC SYSTEM DESCRIPTION

CONTROLS & INDICATORS (cont'd.)

DC Pump Switch

This three-position switch (BRAKE ACC/OFF/EMERG FLAPS) controls operation of the DC pump and its related selector valve. Holding the switch in the momentary BRAKE ACC position will start the DC pump and port the selector valve to direct pump output pressure to both brake system accumulators, the Captain's windshield wipers, and the forward and rear stair systems. Placing the switch in the fixed EMERG FLAPS position will start the pump and port the selector valve to direct pump output pressure to the No. 2 side of the flap system; this will permit up to 18° of flap extension in an emergency. This is further explained in Chapter 12 - FLIGHT CONTROLS of this manual.

BRAKE SYSTEM DESCRIPTION

WHEEL BRAKES

Hydraulically operated brakes are incorporated in the main wheels only. Two independent braking systems are provided, one foot pedal operated and the other hand operated. Both systems use the No. 2 hydraulic system supply. Gauges are provided to indicate the pressures available to foot brakes, brake accumulators, and hand brakes. Brake temperature gauges are also installed. The foot pedal system has anti-skid protection available and permits the use of differential braking.

The hand brake system is applied by brake handles, one on each side of the center console, and applies equal pressure to all wheel brakes simultaneously. Normal accumulator pressure will allow a minimum of 6 full hand brake applications. The Captain's hand brake handle can be locked in the BRAKE APPLIED position for parking. A brake accumulator is installed in each brake hydraulic system to supply an emergency source of pressure, if needed.

A small electrically operated DC pump powered by the battery bus can be used to keep brake accumulators charged for maintenance towing or inflight hydraulic system failure. An automatic wheel braking system, operating through the hand brake system, automatically stops main wheel rotation during gear retraction. Nose wheel rotation is stopped by dual spin brakes located in the nose wheel well.

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BRAKE SYSTEM DESCRIPTION

ANTI-SKID SYSTEM

General Description

This system assists the pilot during landing or aborted takeoff by providing automatic protection against skidding while providing the greatest braking efficiency under all runway conditions.

A skid detector mounted within each axle and driven by the wheel provides information to the anti-skid unit. A sudden change in the rotation rate of a wheel, an impending or actual skid, induces a signal from the anti-skid unit, reducing brake pressure to that wheel to prevent or stop a skid. The anti-skid unit also provides protection against a landing with brake pedals depressed, since brake application is prevented until both shock struts are compressed.

The anti-skid system also provides locked wheel protection. If one wheel stops completely while the corresponding inboard or outboard wheel on the other gear is turning, pressure to the stopped wheel is released completely until it resumes rotation. Locked wheel protection is deactivated below 15 knots to prevent loss of brakes during low speed taxiing and to allow parking. If both inboard wheels or both outboard wheels stop completely, locked wheel protection is lost until one wheel resumes rotation.

The anti-skid system can be tested on the ground or in flight, with the landing gear extended. The landing gear selector lever will deactivate the anti-skid system any time the lever is out of the DOWN position.

NOTE: The test system should not be operated while taxiing, as this will cause loss of brakes for several seconds.

Test Procedures

On-The-Ground

1. Anti-skid switch ON (annunciators show blank).
2. Move switch to OUTBOARD TEST - inboard annunciators show.
3. Release test switch - both inboard and outboard annunciators show REL for one to two seconds then go to blank.
4. Test inboard system as per steps 2 and 3 above.

Inflight

1. All annunciators should show REL when gear is down and locked.
2. Move test switch to OUTBOARD TEST - outboard annunciators should show blank after two seconds.
3. Release test switch - outboard annunciators show REL immediately.
4. Test inboard system as per steps 2 and 3 above.

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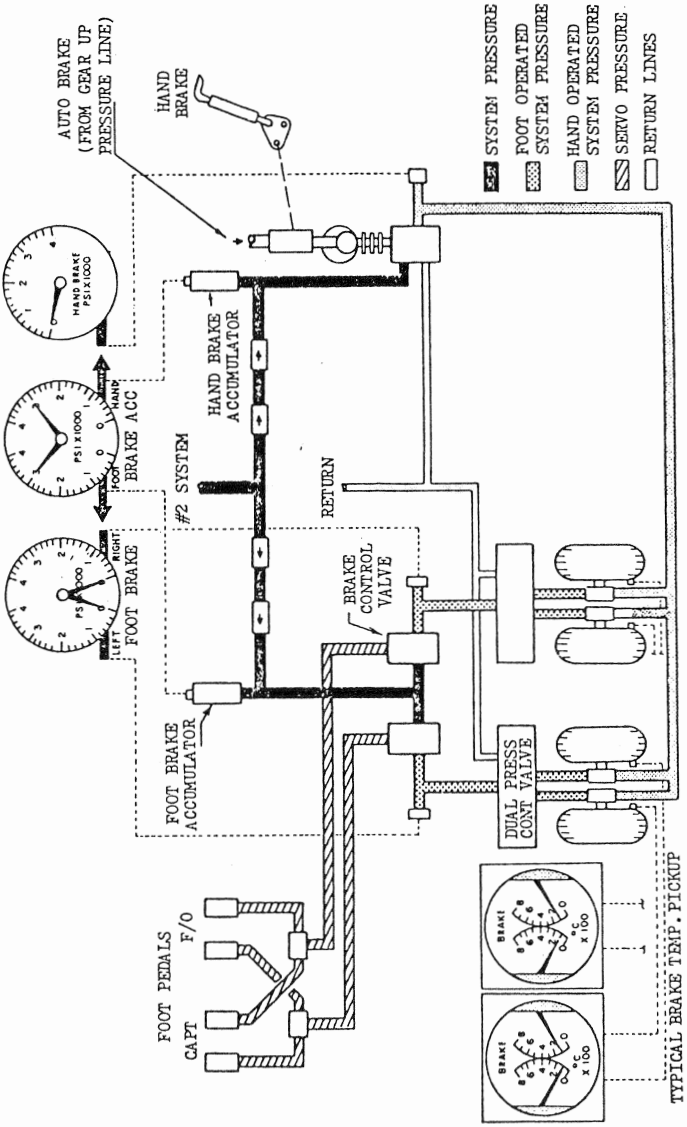
BRAKE SYSTEM DESCRIPTION

SCHEMATIC



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LANDING GEAR SYSTEM DESCRIPTION

GENERAL DESCRIPTION

The landing gear consists of dual wheels on both main and nose gear. The No. 1 hydraulic system is the normal operating power for extension and retraction, with a mechanical backup for manual extension only.

Flight crew control of the landing gear is through a two-position (UP-DOWN) landing gear selector lever. A spring-loaded knob at the end of the lever must be pulled out to disengage a latch mechanism before movement. A solenoid prevents movement of the gear handle to the UP position while the aircraft is on the ground. The solenoid can be overridden by depressing a lever below the landing gear selector lever, however, this feature is not to be used except in cases of emergency.

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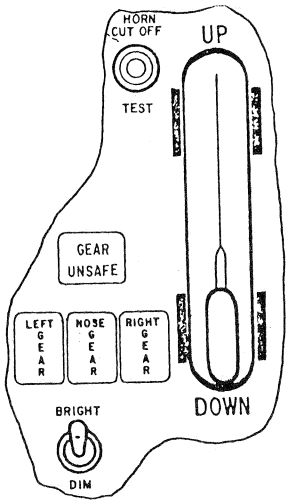
LANDING GEAR SYSTEM DESCRIPTION

CONTROLS & INDICATORS

Gear Indicator Lights



Four gear indicator lights, in conjunction with the landing gear and landing gear selector lever, provide a visual indication of normal or abnormal situations.

Three green gear indicator lights illuminate when the respective gear is down and locked. A dimmer switch is provided for night operation.

The single, red gear unsafe light illuminates when:

- Landing gear selector lever does not agree with landing gear position.
- The main gear doors are not locked.
- All three gears are not locked up or down.
- Landing gear warning horn has been silenced by horn cutoff switch.

LANDING GEAR SYSTEM DESCRIPTION

CONTROLS & INDICATORS (cont'd.)

Mechanical Indicators

Each gear has a mechanical visual indicator which can be used to assure that the gear is down and locked. The main gear indicators are housed in transparent bubbles on the upper surfaces of each wing.

The green indicator should protrude about 1-1/2 inches above the wing when the gear is locked down. However, gear is safe for landing if 1/2-inch or more of green shows above wing top.

The nose gear mechanical indicator consists of a sight tube mounted through the cockpit floor. With the wheel well light switch ON, a green light is visible when the nose gear is down and locked.

Nose gear is safe for landing if at least 75% of lighted green circle is visible.

Landing Gear Warning Horn

Refer to Chapter 12 - FLIGHT CONTROLS of this manual.

NOTE: On modified aircraft, the landing gear warning horn is deactivated above approximately 165 KIAS.

Main Gear Safety Switches

Numerous systems are controlled on landing or takeoff, by relays actuated through microswitches which are operated by compression or extension of the main shock struts.

The main gear safety switches control the following electrical circuits (both struts must be extended or compressed):

Landing Gear Selector Solenoid - Prevents normal movement of gear selector lever to UP position until airplane is airborne.

Stall Warning and Stickpush Systems - Provides approximately 5-second delay after liftoff to prevent inadvertent actuation at takeoff rotation.

Air Conditioning Ground Cooling - Energizes the ground air conditioning fan after a slight delay if air conditioning system is on.

Water Drain System De-Icing - Reduces electrical supply from 115V AC to 28V DC to the two heated water drain masts when on the ground.

Takeoff Warning Horn (On-the-Ground) - Flaps, stabilizer trim, and emergency electric trim warning horn circuits are armed for takeoff.

Generator Ground Cooling Aspirator - Energizes a circuit to allow for cooling air to generators on the ground if the generators are on the line.

Standby Steering - Energizes a solenoid to allow use of standby steering system, if required.

Elevator Gust Damper - Energizes solenoid to allow for gust damping on the ground.

LANDING GEAR SYSTEM DESCRIPTION

CONTROLS & INDICATORS (cont'd.)

Main Gear Safety Switches (cont'd.)

Anti-Skid - Energizes circuitry to lock out "locked wheel" circuit during landing until wheels have rotation speed equivalent to 15 knots of airplane speed.

Airframe Anti-Icing - Prevents actuation of wing and tail anti-icing on the ground, except in TEST position.

Galley Power - Completes circuitry to allow load shedding on the ground.

SAT/TAS Probe Heater - Deactivates SAT/TAS probe heater on the ground, regardless of control switch position.

Cabin FM Radio - Deactivates radio in flight.

Lift Dumpers - Deactivates lift dumpers in flight.

Flight Recorder - Activates flight recorder in flight if not already activated by one of the rear fuel boost pump switches selected ON.

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LANDING GEAR SYSTEM DESCRIPTION

NOSEWHEEL STEERING

A steering wheel is provided on each pilot's console to permit aircraft directional control while on the ground. Hydraulic pressure from the No. 1 system is used through the nose gear down-line. Pressure is made available by actual positioning of the nose gear to the DOWN position. Normal steering range is 78° either side of center.

An interconnect mechanism allows the rudder pedals to be used to control steering up to 10° either side, if the pilot so desires. This mechanism can easily be overridden by the nose steering wheel.

A standby steering system is provided as an alternate means of steering when No. 1 hydraulic system pressure is not available to the nosewheel steering system, i.e., after emergency gear extension, failure of No. 1 hydraulic system, etc. It is energized by selecting the standby steering switch on the left console to ON. An accumulator provides pressure for approximately 220° of total nose wheel movement. An amber low pressure light will illuminate whenever the standby system pressure drops below approximately 2,000 PSI.

The standby steering system should be used only when required and then only after the nose gear has locked down. It should not be used when No. 1 hydraulic system pressure is available to the nosewheel steering system or if nosewheel steering is uncontrollable.

NOTE: If the landing gear has been extended by using the EMERGENCY LANDING GEAR EXTENSION procedure, (Refer to Chapter 1 - EMERGENCY) due to the inability to move the landing gear control handle from the UP position (No. 1 hydraulic system pressure normal), unlimited nosewheel steering is available through either nose steering control wheel. The No. 1 hydraulic system will continually charge the standby steering accumulator with the standby steering switch selected ON.

Rudder fine steering is not dependable with No. 1 hydraulic system pressure, i.e., system inoperative or free fall lever pulled. Hydraulic pressure is required to connect the rudder pedals to the nosewheel steering control cables.

If nosewheel steering is inoperative, the nose wheels will caster freely provided the steering wheels are not restrained. Differential braking can be used for limited directional control.

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LANDING GEAR SYSTEM DESCRIPTION

GEAR DOORS

Four mechanically-actuated doors (two forward and two aft) are connected to the nose gear. The two forward doors are closed any time the gear is not transit, while the two aft doors remain open whenever the gear is extended.

Three doors are fitted to the main gear; a mechanically-actuated outer door, a door attached to the shock absorber strut, and a hydraulically-operated inner door. Both the outer door and the strut door remain open when the gear is extended. The inner door will normally be closed except during gear movement. Following emergency extension of the gear, the inner doors remain open. However, a spring mounted on each door partially closes the door and provides a 2-inch ground clearance. Additionally, a skid is attached at the ground contact point to protect against accidental ground contact.

The main gear doors may be opened on the ground for access to main wheel wells by raising the emergency extension lever.

CAUTION:

- Nose gear ground lock must be installed before raising the emergency extension lever.
- Ascertain that wheel well area is clear before placing emergency extension lever down to close main gear doors; doors close in about 1 second with normal system pressure.
- Do not pressurize any hydraulic system if standby steering accumulator has been completely depressurized (nose wheel well pressure gauge reads zero) as this may collapse nose gear.

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LANDING GEAR SYSTEM DESCRIPTION

LANDING GEAR EMERGENCY EXTENSION

A cable-operated emergency system mechanically releases the gear up locks and allows the gear to "free fall" to the extended position. The lever controlling emergency extension is at the cockpit right side wall aft of the F/O's console under an access door. (See Chapter 1 - EMERGENCY for procedures for EMERGENCY GEAR EXTENSION.)

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FLIGHT CONTROLS SYSTEM DESCRIPTION

GENERAL DESCRIPTION

Primary flight controls consisting of ailerons, spoilers, elevators, and rudder are actuated by conventional cockpit controls. All primary control surfaces, except the ailerons, are moved by hydraulic power actuators. The ailerons are powered aerodynamically. Control system feel forces are produced artificially. The spoilers are used along with the ailerons to provide normal roll control and, when they are all raised simultaneously, they serve as speedbrakes. The most inboard set of spoilers, called lift dumpers, operate only in conjunction with speed brakes and only on-the-ground to improve stopping capability.

Conventional Fowler-type flaps, driven hydraulically, are installed on the wing trailing edge. A hydraulically-driven horizontal stabilizer provides for normal pitch trimming. A stall warning system is installed that provides automatic stickshaker and stickpusher, along with automatic activation of engine ignition.

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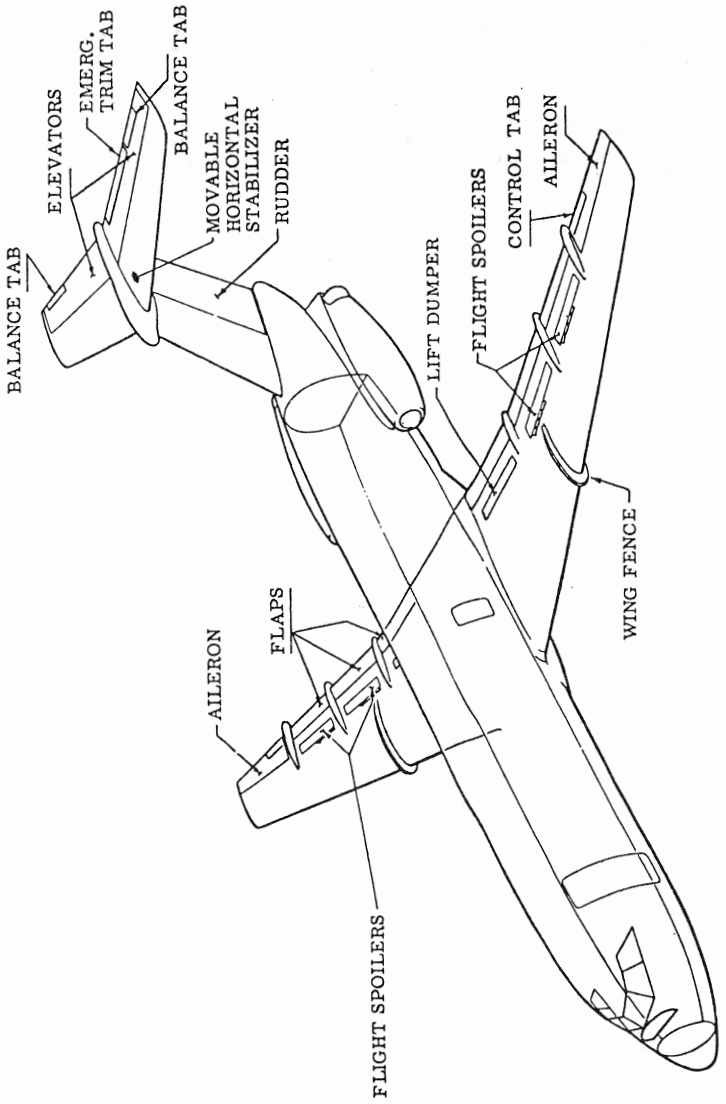
FLIGHT CONTROLS SYSTEM DESCRIPTION

GENERAL DESCRIPTION (cont'd.)



FLIGHT CONTROLS SYSTEM DESCRIPTION

AILERON SYSTEM

The ailerons along with the spoilers provide normal roll control and are quite conventional. A control tab mounted on each aileron responds to control wheel inputs and produces aerodynamic forces to assist in aileron movement. Balance panels mounted in coves forward of the ailerons also assist in moving the ailerons. The aileron control tabs and the ailerons themselves are bused together by linkages and cables to produce a closed-loop system.

Movement of the control tabs through the control wheels applies a load to a torsion bar connected to each tab to provide an artificial feel force in the control system. The aileron trim knob in the cockpit operates a screw jack that applies a preload to the torsion bar at the left control tab. This displaces the tab and hence both ailerons to provide lateral trimming.

The aileron control system and spoiler control system are connected together in such a way that the initial 10° of control wheel movement moves only the ailerons and any further movement moves both ailerons and the spoilers on the down-wing.

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FLIGHT CONTROLS SYSTEM DESCRIPTION

SPOILER/SPEED BRAKE SYSTEM

General Description

Three spoiler panels are located on the upper surface of each wing, just forward of the wing flaps. The most inboard of the spoiler panels are called lift dumpers. The other two panels are called inboard and outboard flight spoilers respectively.

Each flight spoiler is positioned by a single hydraulic actuator, incorporating its own control valve. The actuators for the outboard flight spoilers are powered from hydraulic system No. 1. The inboard flight spoilers are powered from system No. 2. The flight spoilers are connected into the lateral control system such that they operate in conjunction with the aileron on the respective wing and produce roll control if the control wheel is displaced more than about 10°. The spoilers can be deflected about 45° by the lateral control system. At the point where the aileron and spoiler system on each wing physically connect together, a disconnect mechanism is provided to permit the spoiler controls on that wing to be separated from the aileron controls in the event of a jam in the spoiler linkage. The disconnect mechanism will work by applying about 10 pounds at either control wheel against the jam. Once disconnected from the aileron controls, the spoilers on that wing are inoperative.

In addition to their function in the lateral control system, all four flight spoilers can be raised simultaneously to serve as speedbrakes. This is done by pulling aft on the speedbrake handle to establish the amount of spoiler deflection required. The speedbrake handle can produce spoiler deflection up to about 50°, the maximum that the spoiler actuators can produce.

Roll control input and speedbrake handle inputs to the flight spoilers can be applied simultaneously through a mixer linkage provided in each wing. With the spoilers extended to any intermediate position by the speedbrake handle, turning the control wheel commands a further extension of the down-wing spoilers and a corresponding retraction of the up-wing spoilers, the amount of spoiler travel being limited by the physical full travel stops from faired to 50° up.

Flight spoiler extension, whether commanded by roll input of speedbrake handle, is further limited by a blow-down feature. Blow-down is accomplished by a relief valve in each spoiler actuator that opens when air loads pushing down on the actuator piston exceed a predetermined level. Full spoiler deflection is possible only at speeds below approximately 250 knots.

The lift dumpers are controlled by the speedbrake handle only, no connection to lateral controls, and operate only when the airplane is on the ground. The dumpers are not extended in flight because of the airflow disturbance that they would create at the engine inlets. Each dumper is actuated by a single hydraulic actuator, powered from the No. 1 hydraulic system. Pressure to raise the dumpers is applied only when both main gear struts are compressed and the speedbrake handle is pulled full aft.

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FLIGHT CONTROLS SYSTEM DESCRIPTION

SPOILER/SPEED BRAKE SYSTEM (cont'd.)

Controls & Indicators

Spoiler Switches (2)

These switches, located on the forward center panel, control operation of the hydraulic shutoff valve for the respective set (inboard or outboard) of spoilers. With a switch OFF, the respective set of spoilers is unpressurized and will not respond to inputs from either roll controls or speedbrake handle. There is no control switch for the lift dumpers.

Spoiler Fail Lights (2)

These amber lights, located just above the spoiler switches, indicate seizure of a flight spoiler actuator control valve or its input linkage. The light illuminates only when a malfunction exists and the associated spoiler switch is ON.

Speedbrake Handle

The speedbrake handle, located on the pedestal, is used to operate all flight spoilers simultaneously for use as speedbrakes. The handle will also raise the lift dumpers when it is pulled full aft and the airplane is on the ground. The degree of speedbrake deflection versus handle position is shown on a scale on the handle quadrant in increments of 10° up to 50°. Actual spoiler deflection at speeds above about 250 knots may be less than that called for by the handle due to blow-down effect.

An interference collar, that can be manually raised or lowered, is mounted on the handle. When the collar is raised to the TAKEOFF & LAND position, it permits full aft travel of the handle. When the collar is lowered to the FLIGHT position, it contacts a stop in the quadrant when the handle is pulled aft to 20° and prevents more than this amount of spoiler extension.

Lift Dump Annunciators (2)

One annunciator is provided for each lift dumper and is located on the forward center panel. The annunciator will show solid black when the respective lift dumper is full down. It shows OUT if the dumper leaves the full down position, and it shows PWR OFF if power to the annunciator circuit is interrupted.

In addition, lift dump extend lights are incorporated into the forward glareshield panel. They will illuminate anytime the respective lift dumper is not fully stowed.

The yellow lights are tested through the TEST function of the left mode annunciator light switch.

Like the lift dump annunciators, the extend lights are powered from the ESS DC bus through C/B #231, Panel B-4.

FLIGHT CONTROLS SYSTEM DESCRIPTION

RUDDER SYSTEM

General Description

Directional control is provided by a single rudder, normally moved by two hydraulic power actuators through conventional rudder pedals. The lower rudder power actuator is supplied from hydraulic system No. 1 and the upper actuator is supplied from hydraulic system No. 2. Either of the two power actuators will provide normal rudder operation. In the event that no hydraulic pressure is available to either actuator, the rudder can be moved manually; however, the rudder travel available under this condition is very limited. The power actuators serve as gust dampers when hydraulic pressure is not applied.

Hydraulic pressure is delivered to each rudder actuator through an electrically-operated shutoff valve called an auto-isolate valve. The valve is controlled by a microswitch that is connected into the rudder linkage to the actuator in such a way that the switch is actuated if the power actuator control valve is jammed and the linkage is calling for rudder movement. Actuation of the switch automatically closes the auto-isolate valve and shuts off hydraulic pressure to the respective power actuator. It also turns on a red light in the respective flight controls shutoff lever in the cockpit.

A force limiter is installed in the linkage from the rudder pedals to the power actuator to limit the load that can be applied to the rudder system. The device will "break out" if force at the rudder pedals exceeds about 180 pounds.

Rudder system feel is applied artificially by a hydraulic feel device, since airload on the rudder cannot be felt. Feel force is varied by applying modulated hydraulic pressure to the feel device as a function of airspeed. Hydraulic pressure is supplied from both hydraulic system No. 1 and No. 2. Feel is the same with one or both systems supplying pressure. Airspeed is sensed through two pitot heads (Q inlets) on the vertical fin and four static ports on the aft fuselage. Rudder trim is applied through a conventional trim knob in the cockpit which changes the neutral reference of the artificial feel unit and, thereby shifts the neutral position of the rudder. No rudder trim is available without hydraulic pressure applied to the rudder system.

Directional stability of the airplane is improved by the autopilot yaw damper. (Detailed further in Chapter 14 - AUTO FLIGHT SYSTEM of this manual.)

FLIGHT CONTROLS SYSTEM DESCRIPTION

RUDDER SYSTEM (cont'd.)

Controls & Indicators

Rudder Pedal Adjustment

The rudder pedals at each station can be adjusted fore and aft to suit the pilot's stature. A pedal adjustment knob is located on each console. When the knob is pulled out, the pedals are unlocked and, if unrestrained, will move under spring tension to the desired position and they will lock in that position when the knob is released.

Feel Warning Light

An amber feel warning light is installed on the left side of the Captain's instrument panel. It will illuminate for any of the following conditions:

- One rudder feel unit is inoperative.
- Only one of the two hydraulic systems is pressurized.
- Either flying control (chop) lever is in the OFF position.
- Internal leakage within an elevator feel unit, causing excessive back-pressure in common elevator feel and rudder feel hydraulic return line.

FLIGHT CONTROLS SYSTEM DESCRIPTION

ELEVATOR SYSTEM

General Description

Pitch control is provided through two independent elevators, operated in a conventional manner from interconnected yokes in the cockpit. Each elevator is normally moved by a tandem-type or dual hydraulic power actuator. One side of each actuator receives pressure from each hydraulic system such that failure of either hydraulic system still permits normal hydraulic operation of the elevators. In the event of failure of both normal hydraulic systems, hydraulic pressure to the No. 2 side of both elevator actuators can be made available from an emergency elevator system. In the event no hydraulic pressure is available, the elevators can be moved manually, referred to as manual reversion mode.

Hydraulic pressure is delivered to both elevator actuators through an electrically-operated shutoff valve, called an auto-isolate valve, in each hydraulic system. Each auto-isolate valve is controlled by two switches in the elevator control linkage that are actuated if a power actuator control valve for that system should seize and the linkage is calling for elevator movement. Actuation of either switch automatically closes the respective auto-isolate valve and shuts off hydraulic pressure to both elevator actuators from that system. It also illuminates a light in the respective flight control shutoff lever in the cockpit.

Elevator system feel is applied artificially when the elevators are operated in the powered mode, since air load on the elevators cannot be felt. Feel force is varied by applying modulated hydraulic pressure to the feel device as a function of airspeed. Hydraulic pressure is supplied from both hydraulic system No. 1 and No. 2. Airspeed is sensed through 2 pitot heads (Q inlets) on the vertical fin and four static ports on the aft fuselage. These are the same pitot/static ports used for rudder feel. Failure of either normal hydraulic system will not alter elevator feel force. However, if elevator hydraulic pressure is being supplied from the emergency elevator system, the feel force will always be about the same as that provided by the normal system at 180 knots. When the elevators are operated in manual reversion mode, elevator feel is applied by the airload on the elevators.

Pitch trim is normally provided by the variable incidence horizontal stabilizer (see STABILIZER SYSTEM, Section 12-30 in this chapter). An electrically-operated trim tab is installed on the left elevator to provide pitch trim only when the elevators are operated in the manual reversion mode with the horizontal stabilizer inoperative.

A balance tab is provided on each elevator which assists in elevator movement, primarily when the elevators are operated in the manual reversion mode.

Elevator gust damping is provided on-the-ground by the No. 1 side of each elevator power actuator. The damping function is controlled electrically by the operation of the landing gear squat switches. With the weight of the airplane on the main gears, the damper function is activated automatically when pressure is removed from the No. 1 hydraulic system. When the damper function in both power actuators is activated, the green damper engaged light on the forward center panel will illuminate provided power is applied to the ESS DC bus.

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FLIGHT CONTROLS SYSTEM DESCRIPTION

ELEVATOR SYSTEM (cont'd.)

Controls & Indicators

Emergency Elevator Switch

This two position switch (OFF-EMERG) is located on the pedestal. Placing the switch in the EMERG position, accomplishes the following:

- Starts the No. 2 auxiliary hydraulic pump if its control switch is OFF.

- Operates two gate valves in the No. 2 auxiliary pump hydraulic supply lines such that fluid to the pump directly from No. 2 main reservoir is cutoff and fluid from the emergency AC pump reservoir is directed to the pump.

- Operates a selector valve that directs the output of the No. 2 auxiliary pump to the No. 2 side of both elevator actuators and to the emergency pressure port of the elevator feel unit only. The valve prevents the auxiliary pump from supplying any other No. 2 system components.

Emergency Elevator Fail Light

This red light is located adjacent to the emergency elevator switch and functions only when the emergency elevator system is in use; i.e. emergency elevator switch in EMERG position. The light will illuminate if the control valve on the No. 2 side of either elevator power actuator should seize and a control input is applied. The same circuit that illuminates the light also moves the emergency elevator selector valve to shut off the supply of No. 2 auxiliary pump pressure to the emergency elevator system. Assuming that the only source of pressure to the elevator is from the emergency elevator system at this time, cutting off the pressure will revert the elevators to the manual reversion mode. The No. 2 auxiliary pump will continue to run if the red fail light illuminates and can be turned off only by returning the emergency elevator switch to OFF. This action will extinguish the red light.

Emergency Elevator LP (Low Pressure) Light

This amber light is located adjacent to the emergency elevator fail light. Like the fail light, it functions only when the emergency elevator system is in use. It will illuminate if the pressure in the emergency elevator system falls below the value required to sustain normal powered elevator operation, about 2,000 PSI. The light is extinguished by returning the emergency elevator switch to OFF.

(cont'd.)

FLIGHT CONTROLS SYSTEM DESCRIPTION

ELEVATOR SYSTEM (cont'd.)

Controls & Indicators (cont'd.)

Elevator Trim Switches and Indicator

The elevator trim switches are located on the pedestal. The guarded switch, with ON-OFF positions, is used to activate the elevator trim system. The adjacent switch, with momentary NOSE UP and NOSE DOWN positions, is used to position the elevator trim tab on the left elevator to provide desired pitch trim when the elevators are being operated in the manual reversion mode.

The elevator trim tab position indicator is located on the forward center instrument panel. It indicates trim tab position (in units) in terms of airplane response (nose-up or nose-down) to tab movement.

The elevator tab position is incorporated into the takeoff aural warning system. It will sound when throttles are advanced to takeoff and the tab is not in the rigged zero (0) position.

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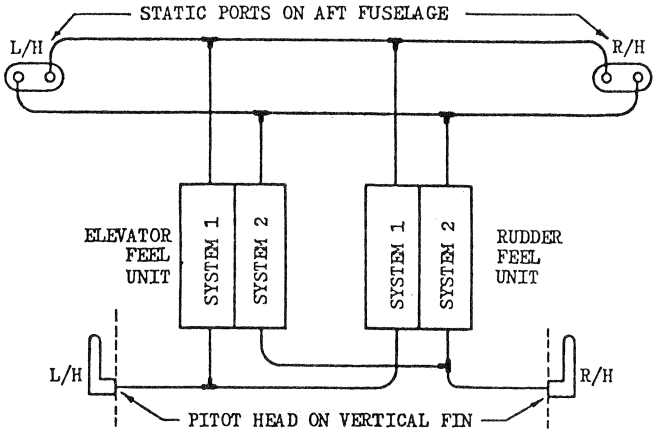
FLIGHT CONTROLS SYSTEM DESCRIPTION

ELEVATOR AND RUDDER FEEL PITOT/STATIC SYSTEM SCHEMATIC



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FLIGHT CONTROLS SYSTEM DESCRIPTION

STABILIZER SYSTEM

General Description

Normal pitch trim is provided by varying the incidence of the horizontal stabilizer. The stabilizer is positioned by a conventional ball-type screw jack driven by two hydraulic motors. Each motor receives hydraulic pressure from one of the hydraulic systems, and either motor is capable of driving the stabilizer. Both motors driving the stabilizer together will move it at a rate of about 2/3° per second. With only one motor, the rate is slightly reduced. Failure of both hydraulic systems will prevent any stabilizer movement.

Hydraulic pressure to each stabilizer motor is supplied through an electrically-operated shutoff valve and a spring-loaded poppet valve in the stabilizer control unit. The electrically-operated valve permits shutting off hydraulic pressure from a switch in the cockpit. The poppet valve will close and shut off pressure automatically if the respective control valve should jam and a control input is applied. When this occurs, it also operates a microswitch that illuminates a light in the cockpit.

A Mach trim servo and an autopilot servo are connected into the stabilizer input linkage. The function of the Mach trim servo is explained in this chapter and the function of the autopilot servo is explained in Chapter 14 - AUTO FLIGHT SYSTEM of this manual.

FLIGHT CONTROLS SYSTEM DESCRIPTION

STABILIZER SYSTEM (cont'd.)

Controls & Indicators

Stabilizer (TPI) Switches (2)

The stabilizer switches, labeled "TPI" (meaning Tail Plane Incidence), are located on the forward center panel. These switches control operation of the electrically-operated hydraulic shutoff valve for the respective stabilizer trim motor. When both switches are OFF, the stabilizer is inoperative.

Stabilizer Fail Lights (2)

These amber lights are located just above the stabilizer switches and will illuminate if the respective stabilizer motor control valve is seized and an input is applied. When the light is illuminated, pressure to the respective control valve is cutoff automatically by a poppet valve. Light is extinguished when respective TPI switch is placed to OFF position.

Stabilizer Trim Wheels (2)

Either of the two interconnected wheels on the pedestal can be used to apply stabilizer trim. The wheels are connected through linkages, etc., to both stabilizer control valves. A scale is provided adjacent to each wheel which shows stabilizer position in degrees in terms of airplane response, from 2° nose-down to 11° nose-up. About 9 revolutions of the trim wheels are required to produce the full 13° of stabilizer travel. A white band on each control wheel scale that extends from 1/2° nose-up to 5-1/2° nose-up indicates the allowable range of stabilizer settings for takeoff. If trim is set outside this range, the takeoff warning horn will sound.

Stabilizer (Electric) Position Indicator

This indicator is labeled tail trim and is located on the forward center panel. It indicates stabilizer position in degrees in terms of airplane response, nose-up or nose-down, provided power is applied to the ESS AC bus.

FLIGHT CONTROLS SYSTEM DESCRIPTION

WING FLAP SYSTEM

General Description

The airplane is equipped with Fowler-type trailing edge flaps. Three flap sections are mounted on each wing and are driven by four screw jacks. The screw jacks are, in turn, driven from a drive unit in the fuselage that utilizes two hydraulic motors. One motor receives hydraulic pressure from hydraulic system No. 1 and the other motor is pressurized from system No. 2. Both motors normally drive the flaps; however, one motor will drive them at a slightly reduced rate in the event one hydraulic system is inoperative. Normal travel time for the flaps from full UP to full DOWN is about 30 seconds.

All eight of the flap screw jacks are driven through two independent drive shaft systems, a primary shaft and a secondary shaft. Normally, only the primary shaft carries the flap load and the secondary shaft rotates without load. However, if the primary shaft should fail, the secondary shaft automatically takes over to drive the flaps. When this occurs, a microswitch is actuated to illuminate the flap shaft fail light on the forward center panel.

In the event of failure of both normal hydraulic systems, the flaps can be operated at a limited rate by use of the DC hydraulic pump. In this case, the flaps should not be extended more than 18° due to the limited flow available from the DC pump. It takes about 4 minutes to extend the flaps from 0° to 18° using this method. Pressure from the DC pump is applied only to the No. 2 motor in the flap drive system.

Microswitches, incorporated in the linkage to the flap selector valves, will illuminate a warning light in the handle of the respective flight control shutoff lever if a selector valve should seize and a flap lever input is applied. There is no automatic isolation of a seized flap control valve.

FLIGHT CONTROLS SYSTEM DESCRIPTION

WING FLAP SYSTEM (cont'd.)

Controls & Indicators

Flap Lever

The flap lever is mounted on the pedestal and is connected through linkage, cables, etc., to the two control valves on the flap drive unit. The lever quadrant incorporates detents at UP, 3°, 8°, 18°, 26°, and 45° full DOWN positions. The lever must be raised to be disengaged from a detent position. A gate is provided at the 18° position to prevent flap lever movement past that position without a pause. The lever must be moved around the gate.

Flap Position Indicator

This indicator is located on the forward center panel. Two pointers are provided on the indicator to show the position of left wing flaps and right wing flaps in degrees, corresponding to flap lever detent positions. The indicator uses power from the ESS AC bus.

Flap Shaft Fail Light

This amber light is located on the forward center panel and will illuminate if the primary flap drive shaft should fail and the secondary drive shaft has engaged to drive the flaps. Flap operation should be normal even with the light illuminated.

DC Pump (Emergency Flaps) Switch

This three-position switch (EMERG FLAPS-OFF-BRAKE ACC) is located on the hydraulic control panel. The BRAKE ACC position is discussed in Chapter 11 - HYDRAULICS, BRAKES, & LANDING GEAR of this manual. When the switch is placed in the EMERG FLAPS position, the DC hydraulic pump will start and a selector valve is moved to port DC pump pressure through a shuttle valve to the No. 2 flap selector valve. Fluid for the DC pump is taken directly from the No. 2 system main reservoir. The flap lever must be positioned to obtain flap movement as it is for normal flap operation.

FLIGHT CONTROLS SYSTEM DESCRIPTION

FLIGHT CONTROLS SHUTOFF AND FAILURE WARNING SYSTEM

The normal supply of hydraulic pressure to all flight controls from system No. 1 and No. 2 passes through a manually operated shutoff valve in the respective system. Each shutoff valve is controlled by a lever on the forward end of the pedestal. Pulling a lever full aft will close the respective shutoff valve through a series of cables, linkages, etc.

A red warning light is incorporated in the knob of each shutoff lever. The light will illuminate, provided the lever is in its forward (ON) position, in the event of seizure of the respective system control valve in the rudder, elevator, or wing flap system when a control input is applied. Illumination of the light in the lever also turns on the master warning lights. The light in the lever will extinguish when the lever is moved to the OFF position.

A pushbutton test switch is located on the pedestal adjacent to the two levers and is used to test the lights in the levers. The lights will illuminate when the button is depressed provided the levers are in the OFF position.

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FLIGHT CONTROLS SYSTEM DESCRIPTION

MACH TRIM SYSTEM

General Description

The Mach trim system provides automatic horizontal stabilizer trim to compensate for aircraft instability at high Mach numbers. The system becomes armed when airspeed is increased above Mach .68 and altitude is above 9,600 feet. As speed is further increased, the Mach trim system begins to automatically adjust the horizontal stabilizer to provide small trim corrections. Any correction to stabilizer position made by the Mach trim system as speed increases is eventually subtracted as speed decreases.

Electrical interlocks automatically prevent operation of the Mach trim system whenever the autopilot is engaged, or whenever the stabilizer trim wheels are moved more than 1° in either direction.

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FLIGHT CONTROLS SYSTEM DESCRIPTION

MACH TRIM SYSTEM (cont'd.)

Controls & Indicators

Mach Trim Master Switch

The Mach trim master switch is located on the pedestal and controls the power supply to the Mach trim controller. Normally this switch is left ON for all flight operation, as specified in Chapter 3 - NORMAL OPERATING PROCEDURES of this manual.

Mach Trim Controller

This unit is located in the radio rack and contains a Mach sensor and electrical circuits for control of the Mach trim servo. The Mach sensor is connected to the airplane auxiliary pitot and static systems and converts the Mach signals to electrical signals. The amplifier portion of the controller uses these signals to operate relays which, in turn, operate the Mach trim servo. The controller automatically disarms the system when the airplane altitude is less than about 9,600 feet and the airspeed is less than .68 Mach.

Mach Trim Servo

The Mach trim servo is located under the pedestal and is indirectly connected to the stabilizer trim wheels when the autopilot is disconnected. When the Mach trim controller sends a signal to the Mach trim servo and the autopilot is disengaged, it moves the stabilizer in the same manner as when it is manually trimmed using the trim wheel. When the autopilot is engaged, the controller will continue to compute signals and operate the servo; however, stabilizer trim is not affected since the servo is disengaged.

Activity Light and Switch

This amber light and associated switch are located on the pedestal. The activity switch has two positions, FULL TIME and A/P INTERLOCK. With the switch in the FULL TIME position, the activity light will illuminate any time the Mach trim controller sends a signal to the Mach trim servo. With the switch in the A/P INTERLOCK position, the light illuminates only when the autopilot is not engaged.

Supplied by Jeppesen Sanderson

FLIGHT CONTROLS SYSTEM DESCRIPTION

STALL WARNING SYSTEM

General Description

Two stall warning systems, identified as system No. 1 and system No. 2, are installed to provide three separate functions during an approach to stall (approaching the speed Vs) as follows:

- At about 115% of Vs, both high and low energy ignition systems are energized to provide for immediate engine relight in the event of engine flameout due to airflow disturbances at the engine inlets.

- At about 110% of Vs, a stickshaker motor on each control column is activated to provide a sense-of-feel warning and an audible warning of the approaching stall.

- At about 104% of Vs, a stickpusher at the base of the Captain's control column is activated to physically force both columns forward for initiation of the stall recovery maneuver.

Each stall warning system utilizes duplicated components to produce the functions given above. Stall sensing signals are provided by four vane-type, angle-of-attack sensors located on the fuselage, system No. 1 vanes on the left and system No. 2 vanes on the right. The two aft vanes on each side provide signals for auto-ignition and stickshake in the respective system. The two forward vanes provide signals for stickpush in the respective system. All four sensors are electrically anti-iced, as explained in Chapter 6 - ICE & RAIN PROTECTION of this manual.

Auto-ignition is provided by the same engine ignition components that are used for engine starting (covered in Chapter 16 - POWERPLANT & AUXILIARY POWER of this manual). Stall warning system No. 1 activates the high energy igniters in both engines and system No. 2 activates the low energy igniters in both engines. The igniter on lights located on the overhead panel illuminate as the respective igniter is activated.

Stickshake is produced by a small motor mounted on the forward side of each control column. The motor drives an eccentrically mounted weight that induces vibration in the column and provides an audible sound in the cockpit. The shaker motor on the Captain's column is activated by stall warning system No. 1 and the motor on the F/O's column is activated by system No. 2. The stickpusher cannot function until after one of the stickshakers has operated.

(cont'd.)

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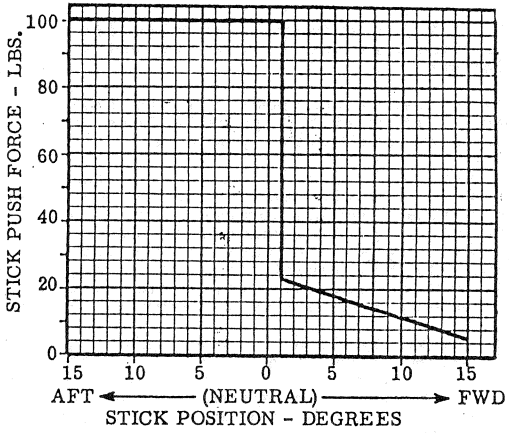
FLIGHT CONTROLS SYSTEM DESCRIPTION

STALL WARNING SYSTEM (cont'd.)

General Description (cont'd.)

Stickpush is provided by a pneumatic actuator connected to the base of the Captain's control column. The actuator is designed such that the force applied to the control columns is proportional to the position of the columns. Force vs. Column Position is illustrated on the following chart:



The pusher actuator is supplied with nitrogen pressure from a storage bottle located in the E & E compartment. The pressure is reduced and then delivered to the pusher actuator through two electrically-controlled pneumatic valves, called valves "A" and "B". The valves are plumbed in series such that both valves must open for the pusher actuator to function. A manually-operated valve is provided to permit dumping pusher actuator pressure when desired. The stickpusher cannot function until after one of the stickshakers has been activated. However, if the pusher does not function within about 60 seconds after a shaker signal is received, the pusher is locked out until the angle-of-attack is less than that required to activate the shakers.

Two klaxon-type warning horns are incorporated in the stickpusher circuits, one in stall warning system No. 1 and one in system No. 2. Either or both of these horns will sound when the pusher is activated; however, the horns can be cutout of the pusher circuits, if desired.

FLIGHT CONTROLS SYSTEM DESCRIPTION

STALL WARNING SYSTEM (cont'd.)

Controls & Indicators

Stall Warning Test Switches (3)

These three switches, one for stickshake, one for stickpush, and one for auto-ignition, are located on the overhead panel. Each switch has three positions: NO. 1-OFF-NO. 2. Moving the switches to the momentary NO. 1 or NO. 2 position will test the respective function for that stall warning system. The stickpush test and stickshake test switches must be held in the NO. 1 or NO. 2 position to test the stickpush function in either position. The stickpush test switch is inoperative in flight.

Valve Open Lights (2)

These red lights, marked A and B, are located on the overhead panel. A light will illuminate when the respective stickpusher control valve is open, whether or not a stickpush signal has been received. Both lights illuminate when the stickpusher functions normally.

Low Pressure Light

This red light is located on the overhead panel and will illuminate if the reduced pressure in the stickpusher system is below its normal value (of approximately 45 PSI).

System Fail Light

This red light is located on the overhead panel and indicates a failure in some electrical portion of the stall warning system. The light will illuminate if:

- Electrical power to the shaker or pusher systems has failed.
- A signal from the pusher system is present but no shaker signal has been generated.
- A shake signal is generated, but no stickpush and no stall recovery occurs within 60 seconds.
- The pusher dump handle is pulled.

Pusher Fail Lights (2)

These red lights are located on the Captain's and F/O's instrument panels respectively. The lights operate together and will illuminate if:

- Either of the valve open light (A or B) illuminates and there is no stickshake signal present.
- The low pressure light is illuminated.
- The system fail light is illuminated, except this light will not illuminate if the system fail light is illuminated because the pusher dump handle is pulled.

Stickpush Lights (2)

These amber lights are located on the Captain's and F/O's instrument panels respectively. The lights operate together and will illuminate if the stickpusher actuator leaves the stowed (retracted) position.

FLIGHT CONTROLS SYSTEM DESCRIPTION

STALL WARNING SYSTEM (cont'd.)

Controls & Indicators (cont'd.)

Stickpusher Dump Handle

This handle is located on the pedestal. When it is pulled, it operates a valve that dumps pressure in, and going to the stickpusher actuator. It also operates a microswitch that prevents operation of the stickpusher valves A and B. The handle must be rotated about 1/2 turn in either direction before it can be pulled out. Once it is pulled, it is locked in the OUT position by a small mechanical catch that normally must be reset by Maintenance.

Stickpusher Klaxons Switch

This two-position switch (ON-OFF)is located on the left console. The switch is guarded to the ON position. When it is turned OFF, it deactivates both warning horns in the stickpush circuits.

Stickpush Pressure Gauge

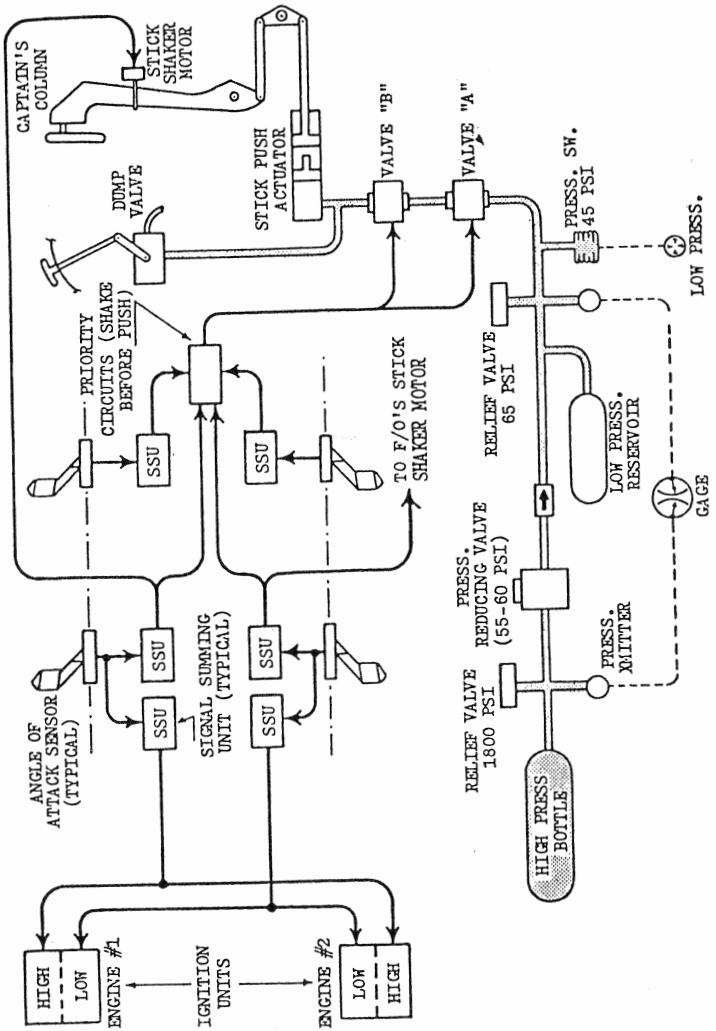
Located above the right console is a dual indicator. The indicator scale on the right shows nitrogen pressure in the stickpusher high pressure bottle. The normal high pressure charge, which is about 1,500 PSI, will provide about 250 "pushes" from the pusher actuator. The minimum high pressure charge, which is 500 PSI (the beginning of the red arc on the gauge), will provide about 25-30 "pushes."

The indicator scale on the left shows nitrogen pressure to the pusher control valves and actuator.

FLIGHT CONTROLS SYSTEM DESCRIPTION

STALL WARNING SYSTEM (cont'd.)

Schematic



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FLIGHT CONTROLS SYSTEM DESCRIPTION

MASTER WARNING SYSTEM

Two master warning lights, one on each pilot's instrument panel, give an immediate indication of certain system failures. Each light incorporates a PUSH ON/PULL OFF type switch and indicates by flashing when a system failure light is illuminated. The system fail lights included in the master warning system are:

- No. 1 or No. 2 bus fail
- DC fail (bus)
- Left or right booster pump low pressure
- No. 1 or No. 2 engine overheat
- No. 1 or No. 2 oil low pressure
- No. 1 or No. 2 flying controls
- Emergency elevator fail

To prevent nuisance flashing of the master warning lights, the circuits for the No. 1 or No. 2 bus fail and the left or right booster pump low pressure have built-in time delays.

Whenever one or more of the system failure lights is illuminated, the master warning lights also illuminate. The master warning lights flash alternately until:

- The failure condition is corrected, or
- The system failure lamp is cancelled, or
- The master warning lamp is cancelled.

If only one master warning light is cancelled, light remains on steady, the other master warning light will continue to flash. If the affected system failure light is cancelled, the master warning system will be reset.

All system failure lights are the PULL-TO-CANCEL type, except the No. 1 or No. 2 flying controls and the emergency elevator fail. These lights must be cancelled by deactivating the affected system.

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FLIGHT CONTROLS SYSTEM DESCRIPTION

WARNING HORN

A single warning horn is installed in the left ceiling of the cockpit to provide an aural warning for certain flight control, landing gear, or cabin altitude conditions. The horn will produce either a steady or interrupted tone, depending upon the source of the input signal. Warnings are provided for the following:

Takeoff Warning (On-the-Ground)

This warning indicates that the airplane is not in the proper configuration for takeoff. The horn will sound intermittently with the airplane on-the-ground and either throttle advanced into the takeoff range if:

- Stabilizer is not set within range of 1/2° to 5-1/2° airplane nose-up.
- Wing flaps are not set between 3° and 18°.
- Emergency elevator trim is not set at 0°.
- Speedbrake handle is not stowed in the full forward position.

The horn can only be silenced by correcting the condition causing it.

Speedbrake/Throttle Warning (Inflight)

This warning, referred to as the "high drag" warning, indicates that the airplane is not in the proper configuration for a go-around. The horn will sound intermittently inflight when either throttle is advanced into the takeoff range if the speedbrake handle is not stowed in the full forward position. Actually, this same condition causes a warning on the ground, as previously explained. The horn can only be silenced by correcting the condition causing it.

NOTE: If necessary, the warning horn may be silenced by tripping the landing gear warning C/B #377 on Panel P. Bear in mind, however, that all flight control, landing gear, and cabin altitude aural warnings will be lost when this is done.

Speedbrake/Flap Warning (Inflight)

Horn will sound intermittently anytime the speedbrake handle is not stowed in the full forward position and the wing flaps are extended simultaneously inflight. The horn can only be silenced by correcting the condition causing it.

NOTE: If necessary, the warning horn may be silenced by tripping the landing gear warning C/B #377 on Panel P. Bear in mind, however, that all flight control, landing gear, and cabin altitude aural warnings will be lost when this is done.

Throttle/Landing Gear Warning (Inflight)

Horn will sound steadily if either throttle is retarded below approximately 83% N2 and any gear is not down and locked. The horn can be silenced by actuating the horn cutoff switch, located adjacent to the landing gear handle.

The gear unsafe light will illuminate whenever the horn cutout switch is used to silence the horn, until throttle advancement rearms the warning circuit.

The horn can only be tested if one or both throttles are below the 83% position and the test switch is actuated.

FLIGHT CONTROLS SYSTEM DESCRIPTION

WARNING HORN (cont'd.)

Flaps/Landing Gear Warning (Inflight)

Horn will sound steadily if the wing flaps are extended beyond 18° and any gear is not down and locked. The horn can be silenced only by correcting the condition causing the horn to sound.

NOTE: If necessary, the warning horn may be silenced by tripping the landing gear warning C/B #377 on Panel P. Bear in mind, however, that all flight control, landing gear, and cabin altitude aural warnings will be lost when this is done.

Cabin Altitude Warning

Horn will sound intermittently and amber cabin altitude light on center instrument panel will illuminate if cabin altitude exceeds 10,000 feet. The horn can be silenced by depressing cabin altitude light. After a warning is cancelled, the circuit is rearmed when cabin altitude descends below 10,000 feet.

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FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

PITOT/STATIC SYSTEM

General Description

Measurement of total and static pressure is accomplished through the pitot/static system. This system consists of three independent systems of pitot tubes, static ports, and associated tubing known as the Captain's, the First Officer's, and the auxiliary pitot/static systems.

The Captain's and F/O's pitot/static systems supply pitot and static pressures to a Mach/airspeed indicator, and static pressure alone to a vertical speed indicator and an altimeter at the Captain's and F/O's stations respectively. The Captain's system supplies static pressure to the "third" altimeter. The F/O's system supplies both pitot and static pressures to a Mach/airspeed warning system. The auxiliary pitot/static system supplies both pitot and static pressures to a second Mach/airspeed warning system, autopilot air data sensor, flight recorder, Mach trim sensor, 165 knot airspeed switch, and the 220 knot airspeed switch. The auxiliary pitot/static system also supplies outside ambient static pressure to the differential pressure portion of the cabin altimeter. The pressurization amplifier has its own static port.

Two switches, one labeled ASI (Mach/airspeed indicator) and the other labeled AIR DATA (altimeters and IVSI) are provided on each pilot's panel to permit selection of the alternate static system as an alternate source of static pressure for the respective instruments. Each switch has NORMAL and ALTERNATE positions and is guarded to the NORMAL position.

Anti-icing of the pitot tubes is accomplished with integral electric heaters controlled by switches on the overhead panel.

FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

PITOT/STATIC SYSTEM (cont'd.)

Controls & Indicators

Mach/Airspeed Indicators

Each pilot is provided with a combination Mach/airspeed indicator on his/her panel. These indicators receive pressure signals from the pitot/static system. The airspeed scale on the indicators range from 60 to 400 knots, marked in 2-knot increments from 60 to 200 knots and 10-knot increments from 200 to 400 knots. A red and yellow mark on the scale shows Vmo. Indicated airspeed and Mach number are shown by the movement of a white pointer. A small white triangular preset reference pointer "bug" is movable about the periphery of the airspeed scale. This reference pointer is set by a small knob at the lower left-hand corner of the instrument.

The Mach portion of the instrument is a movable card positioned in a cutout on the outer periphery of the instrument face. The range of the instrument is from 0.5 to 1.0 Mach with a red and yellow limit mark on the movable card at Mmo.

Altimeters

Drum-type altimeters are installed, one on each pilot's panel. Each has a range of -1,000 feet to +50,000 feet. Hundreds of feet are indicated by a radial pointer. Thousands of feet are indicated on a rotating drum visible through a slot in the face of the instrument. A cross-hatched marking is printed on the drum adjacent to the numbers indicating +1,000 feet and below to increase the conspicuity of these lower altitude values. When the Captain's and F/O's altimeters are set in accordance with standard altimeter setting procedures, the cross-hatched marking provides a visual alert that the airplane is 1,000 feet AGL or less.

NOTE: The drum altimeter is being changed to eliminate the cross-hatched marking and make the drum solid white below the zero altitude mark.

Each drum altimeter incorporates an integral vibrator to minimize error caused by sticking or friction in the internal instrument mechanical linkages.

A "third" altimeter, three pointer, is located on the pilot's center panel. Hundreds, thousands, and ten-thousands of feet are indicated by three concentric pivot-mounted hands. The three-pointer is post-lighted and does not incorporate an integral vibrator.

A conventional barometic scale in inches of mercury is provided for setting each altimeter. The scale is adjusted by a knob in the lower left corner of the altimeter. The knob also positions two indices on the periphery of the instrument face which are used for indicating field pressure altitude.

(cont'd.)

FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

PITOT/STATIC SYSTEM (cont'd.)

Controls & Indicators (cont'd.)

Vertical Speed (Rate of Climb) Indicators

Two Instantaneous Vertical Speed Indicators (IVSI), one on each flight instrument panel, indicate airplane rate of climb or descent in FPM. A conventional non-lag-free type indicator installed on the cabin pressurization control panel indicates only cabin altitude rate of change in equivalent FPM.

The IVSI-type indicator provides "instantaneous" indication of aircraft rate of climb or descent by combining the effects of an accelerometer with the conventional static pressure sensing pneumatic device used to actuate the indicator needle. Thus, the functional deficiency of the earlier conventional indicator (the fact that the indication lagged the actual change in vertical speed) is largely eliminated.

Since the accelerometer is not gyro stabilized, it senses an entry into a turn as an acceleration increase just as it senses an acceleration increase when the nose is pulled up to climb. The acceleration in a constant altitude turn is, of course, more than 1G. Because of this effect, the IVSI will initially show a climb when a turn is made, even though constant altitude is maintained. Once in a steady state turn, this error disappears. Conversely, rolling out of a turn, during which airplane acceleration returns to 1G, it will briefly show a descent, even though constant altitude is maintained. Therefore if the needle is kept centered, some loss in altitude will occur when entering a turn and a corresponding gain in altitude will occur when recovering from the turn. This instrument is not designed to be used for directly controlling vertical speed when banking in excess of about 40°.

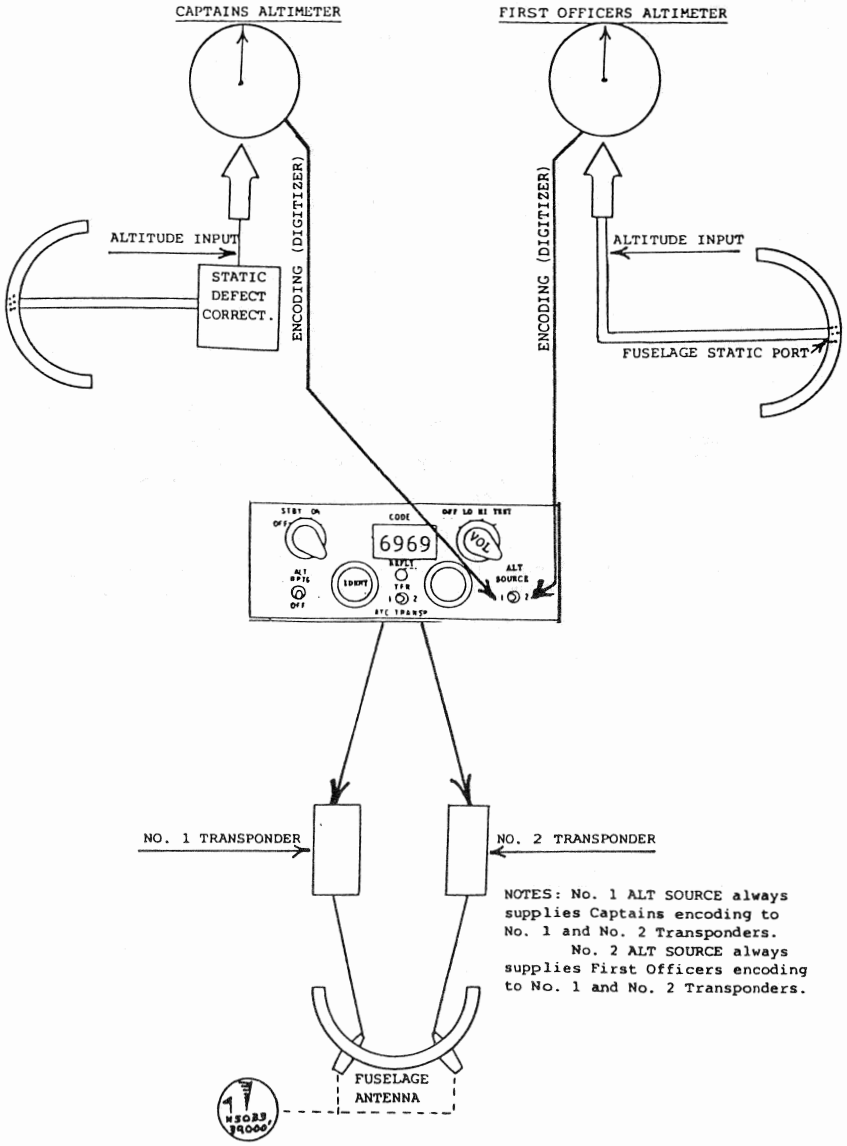
In turbulence, the IVSI will respond with higher sensitivity to the acceleration excursions resulting from the aircraft encountering vertical air currents. However, these indications reflect more accurately what the airplane is actually doing than the conventional indicator provided.

The instrument is calibrated to show vertical speed from 0 to 6,000 FPM, climb or descent.

FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

PITOT/STATIC SYSTEM (cont'd.)

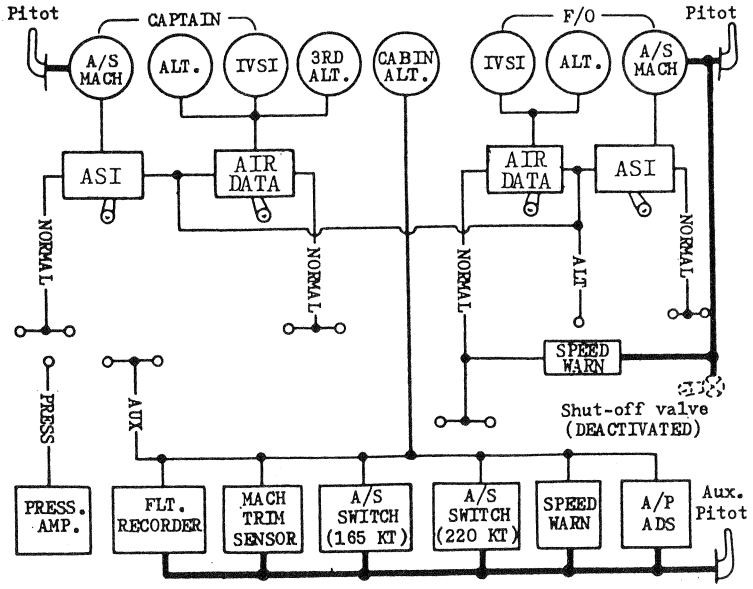
Altimeters Encoding Flow Path and Encoding Source


CAPTAINS ALTIMETER
FIRST OFFICERS ALTIMETER
ALTITUDE INPUT
STATIC DEFECT CORRECT.
ENCODING (DIGITIZER)
ENCODING (DIGITIZER)
ALTITUDE INPUT
FUSELAGE STATIC PORT
6969
NO. 1 TRANSPONDER
NO. 2 TRANSPONDER
FUSELAGE ANTENNA
NOTES: No. 1 ALT SOURCE always supplies Captains encoding to No. 1 and No. 2 Transponders.
No. 2 ALT SOURCE always supplies First Officers encoding to No. 1 and No. 2 Transponders.

FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

PITOT/STATIC SYSTEM (cont'd.)

Functional Schematic



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FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

INDEPENDENT FLIGHT INSTRUMENTS

The following instruments provide direct indications and are independent from any other system or instrumentation:

Turn and Bank Indicators

Turn and bank indicators are mounted on each flight instrument panel. The bank indicator is a conventional ball indicator in a curved, liquid filled tube. The turn needle is operated by a 115V AC electrically-powered gyro. An OFF flag will appear on the face of the instrument in the event of power failure to the instrument.

Total (Ram) Air Temperature Indicator

This instrument, mounted on the center instrument panel, provides an indication (in °C) of total outside air temperature, that is, static air temperature plus "ram rise." The temperature probe incorporating an integral de-icing heater is located on the left side of the forward fuselage and has a recovery factor very near 100%. The temperature at the probe is transmitted to the cockpit gauge through an electrical circuit.

Clocks

Eight-day clocks are installed on the Captain's and F/O's instrument panels. Each clock has a 12-hour dial, conventional hour and minute hands, and a sweep-second hand. The knob in the lower left corner is used to wind the clock and to set the main indicating hands. Rotating the knob counterclockwise winds the clock. Pulling the knob out permits the main hands to be reset by rotating the knob.

Both clocks have an elapsed time feature which consists of a control in the upper right corner with positions STOP/0/GO, and an elapsed time dial in the upper portion of the clock face. The "0" control position resets the hands to zero. The control lever may be rotated from STOP to GO position without resetting the hands.

The pushbutton in the lower right corner is used to alternately start, stop, and reset the sweep-second hand.

Flight Recorder

The flight recorder, located aft of the aft pressure bulkhead provides automatic inflight recording on tape of altitude, airspeed, heading, and vertical acceleration as a function of time. Pitot and static pressures are supplied by the auxiliary pitot/static system. Heading signals are taken from the Captain's RMDI. Vertical acceleration "G" loads are sensed by a remote accelerometer located in the keel beam. The recorder is powered whenever the test switch is depressed, either rear fuel boost pump switch is ON, or either MLG oleo strut is extended (airplane is airborne). An amber light located adjacent to the test switch on the overhead panel illuminates in the event of a power failure or recorder unit malfunction.

(cont'd.)

FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

INDEPENDENT FLIGHT INSTRUMENTS (cont'd.)

Mach/Airspeed Warning Systems

Two independent Mach/airspeed warning systems are installed to provide an aural indication that the aircraft has exceeded Vmo or Mmo, whichever limit is lower at that altitude. The warning device for each system is a non-silenceable clacker which is actuated by an airspeed and Machmeter sensor similar to the airspeed/Machmeter instrument. The clacker will sound continuously if the limiting speed is exceeded and until the aircraft speed is slowed to below the limiting speed.

The No. 1 system receives pitot and static pressure intelligence from the F/O's pitot/static system; the No. 2 system receives pitot/static intelligence from the auxiliary pitot/static system. Circuit protection is through the high speed warning No. 1 and No. 2 C/B's (#116 and #117). Each system can be tested by a switch on the overhead panel.

FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

STANDBY HORIZON

General Description

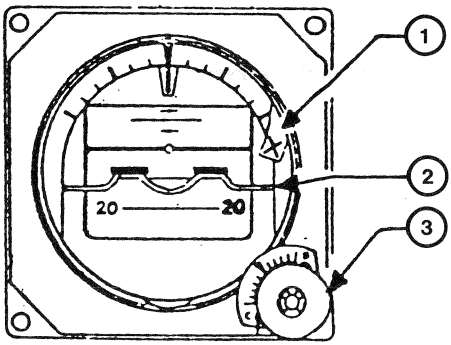
A standby horizon is installed on the lower right side of the Captain's instrument panel.

The instrument has a self-contained gyro, powered by a separate static inverter. The horizon is reliable for about 5 minutes after loss of power. It will indicate about 90° in climb and dive by display of a fixed airplane symbol against a movable sky-ground tape. The tape has a horizontal line (bar) to represent the horizon and a series of horizontal index lines to show airplane pitch angle. The tape can roll 360° in relation to the airplane symbol to show roll attitude.

Operation

Gyro comes up to speed/ in 1 to 2 minutes after power is applied to aircraft. Normal erection rate is 2 to 3 degrees/minute. If gyro is more than about 10° from vertical, fast erect by pulling out pitch trim knob (which cages gyro) and then releasing (do not snap).

Controls & Indicators



(1) Power Failure Warning Flag

Appears when power to instrument is lost (white "X" on red background).

(2) Fixed Airplane Symbol

(3) Pitch Trim Knob

Moves airplane symbol 5° up or down when turned. It cages gyro when pulled out (spring-loaded in).

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FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

ALTITUDE ALERT SYSTEM

General Description

The Altitude Alert System consists of an altitude alert control panel located just below the fire pull handles, a Captain's altimeter (pneumatic) which provides an altitude signal output, and an aural alert device located on the overhead panel. Power is provided by 26V AC and 28V DC C/B's located on the RB-4 panel.

The altimeter signal output is baro corrected and reflects the indicated altitude of the Captain's altimeter. Therefore, the alert system will be coordinated with indications on the Captain's altimeter at any barometric setting.

Lighting of the altitude alert unit is integral and is controlled by the center instrument panel lighting control.

Operation

Set desired (ATC assigned) altitude on alert panel with altitude set knob. Amber light on alert panel illuminates and 2-second aural warning sounds as aircraft approaches 900 feet to selected altitude. At approximately 300 feet from selected altitude, amber light extinguishes. After aircraft is established at selected altitude, amber light will illuminate again and 2-second aural warning will sound whenever aircraft deviates more than 300 feet from selected altitude. Light may be extinguished at any time by depressing it.

Altitude Alert Ground Test

Selected altitude on alert panel should be more than 1,000 feet. (Assumes Captain's altimeter is set to zero feet.)

- Altitude Set Knob - DEPRESS. While depressed, rotate selected altitude down to 0 feet. As selected altitude descends through 900 feet, note that amber warning light on alert panel illuminates and 2-second aural warning sounds. As selected altitude descends through 300 feet, note that amber warning light on alert panel extinguishes.

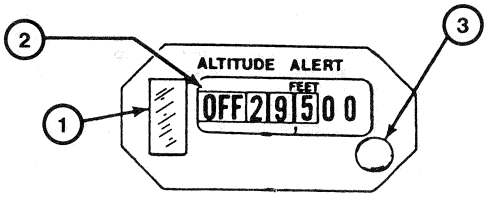
- Altitude Set Knob - RELEASE.

(cont'd.)

FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

ALTITUDE ALERT SYSTEM (cont'd.)

Controls & Indicators



Altitude Alert Panel

(1) Amber Warning Light

Light illuminates when:

- Aircraft is within approximately 900 feet of selected altitude.
- Aircraft deviates from selected altitude by approximately ±300 feet.

Light extinguishes when:

- Aircraft is within approximately 300 feet of selected altitude.
- Light cap is depressed.

A two-second aural warning will sound when aircraft is within approximately 900 feet of selected altitude or deviates from selected altitude by approximately ±300 feet.

(2) Flag

Appears when system is not receiving signals.

(3) Altitude Set Knob

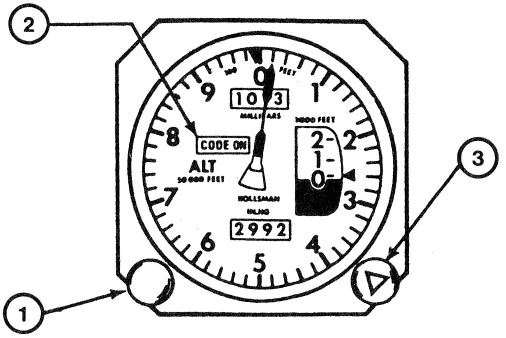
When pressed, it bypasses radio altimeter deactivation circuit to permit ground test of altitude alert system.

Alert signals are deactivated as the radio altimeter passes through 2,500 feet. Altitude alert below 2,500 feet will be a function of the radio altimeter. At this time if it is desired, the digital window may be used as an altitude reminder.

FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

ALTITUDE ALERT SYSTEM (cont'd.)

Controls & Indicators (cont'd.)



Captain's Altimeter

(1) Barometric Setting Knob

Sets inches of HG and millibars.

(2) Code Flag

CODE ON -- Normal operation.

CODE OFF - Indicates failure of altimeter to provide encoded altitude information to the transponder.

(3) Reference Bug Set Knob

Sets reference bug around periphery of dial.

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FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

GROUND PROXIMITY WARNING SYSTEM (GPWS)

General Description

The GPWS provides aural and visual warning of potentially dangerous situations relative to the ground between 50 feet and 2,450 feet radio altitude. The system is off when on the ground, remains off until 50 feet radio altitude is reached, then is automatically deactivated above 2,450 feet. Warnings are triggered by operation within any of five (5) modes:

MODE 1: Excessive rate of descent with respect to terrain (2,450 to 50 feet AGL).

MODE 2: Excessive closure rate to terrain.
2A: Flaps not in landing configuration (1,800 to 50 feet AGL).
2B: Flaps in landing configuration (790 to 220 feet AGL).

MODE 3: Loss of altitude during takeoff or go-around triggered either by excessive altitude loss or sink rate (below 700 feet AGL).

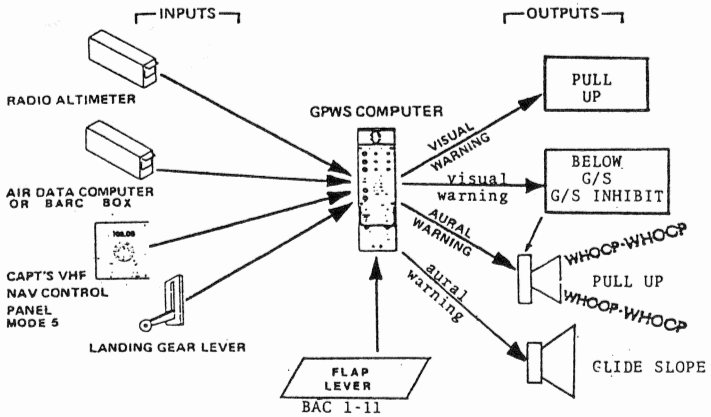
MODE 4: Inadvertent proximity to terrain during approach. (Operational below 500 feet AGL provided that 700 feet AGL had been attained.)

MODE 5: Will provide aural and visual warning of an inadvertent descent below the glideslope when on an ILS approach.

The system does not require pilot inputs and is silent during all normal flight operations. If a warning is activated, corrective action by the pilot is required; such as, applying maximum power, increasing altitude, decreasing rate of descent or bringing the aircraft upwards toward the glideslope center, if that was the cause of the warning.

The required inputs to the GPWS are:

- Altitude above ground level (AGL) from the radio altimeter.
- Barometric rate of change from the BARO (barometric altimeter).
- Landing gear position from the landing gear lever.
- Flap logic from the flap lever (26°).



FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

GROUND PROXIMITY WARNING SYSTEM (GPWS) (cont'd.)

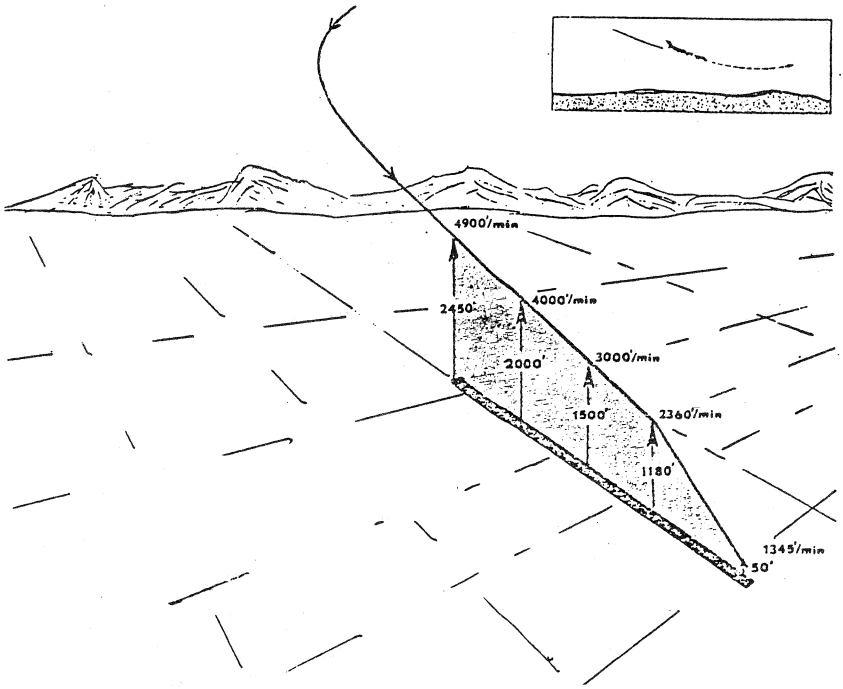
General Description (cont'd.)

The GPWS computer and the aural warning are powered by 115 volts AC/400 HZ, and the visual warning is powered by 28 volts DC. Location of the circuit breakers or fuses are as follows:

- AC power (ESS Bus) - C/B #462
- DC power (ESS Bus) - C/B #459

Mode 1: Excessive Rates of Descent With Respect to Terrain

This mode provides warning if barometric rate of descent is excessive between 2,450 feet and 50 feet AGL. The rate of descent that triggers the warning varies with radio altitude as shown on the following Mode 1 chart. For radio altitudes between 2,450 feet and 1,180 feet, the system is designed to provide a nominal 30-second warning time prior to predicted terrain impact. Below 1,180 feet radio altitude, the warning time is decreased to prevent nuisance warnings during normal terminal operations. This mode is functional regardless of landing gear and flap position inputs at all times between 2,450 feet and 50 feet AGL.



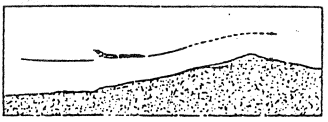
FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

GROUND PROXIMITY WARNING SYSTEM (GPWS) (cont'd.)

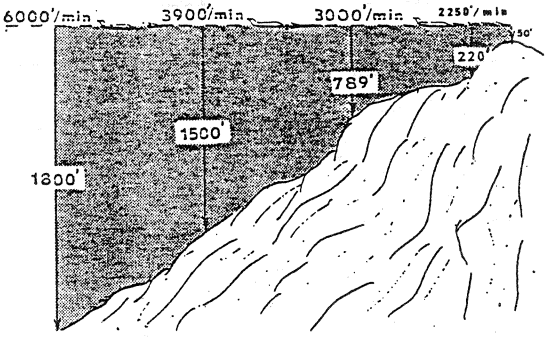
Mode 2: Excessive Closure Rate to Terrain

Basically Mode 2A is designed to trigger a warning when the aircraft is flying level into rising terrain or with the combination of closure rate between the aircraft and terrain at rates in excess of those shown below. Mode 2A is operational between 1,800 feet down to 50 feet AGL at all times that the flaps are not in the landing configuration.

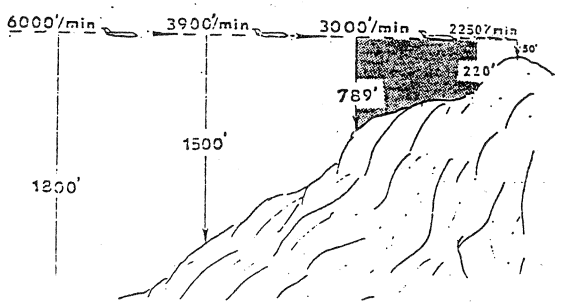
Mode 2B is operational between 790 feet down to 220 feet AGL, when flaps are in the landing configuration and irrespective of landing gear position.



MODE 2A - FLAPS NOT IN LANDING CONFIGURATION



MODE 2B - FLAPS IN LANDING CONFIGURATION



FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

GROUND PROXIMITY WARNING SYSTEM (GPWS) (cont'd.)

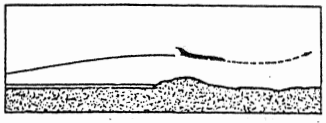
Mode 3: Loss of Altitude During Takeoff or Go-Around Below 700 Feet AGL

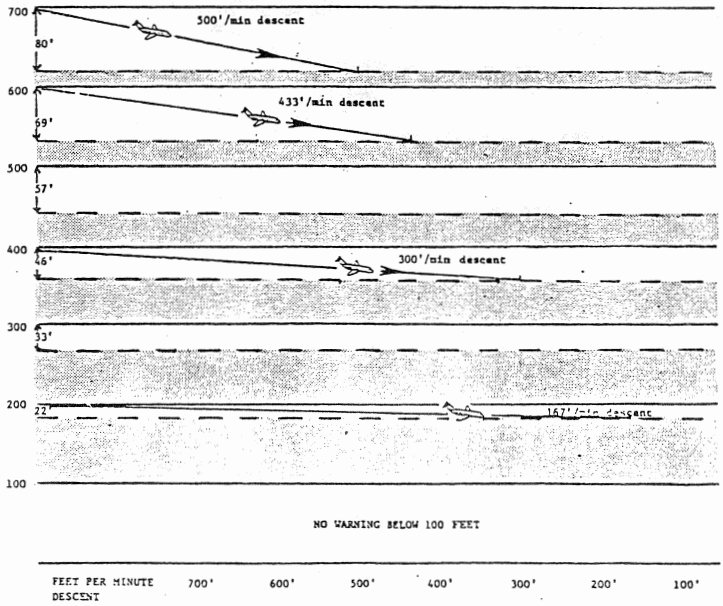
This mode provides warning during takeoff or go-around, triggered either by excessive altitude loss or sink rate.

After takeoff, prior to reaching 700 feet AGL, an accumulated altitude loss representing approximately 10% of the altitude acquired will trigger a warning. Examples: At 700 feet AGL, a loss of 80 feet will trigger a warning; at 100 feet AGL, a loss of 11 feet will trigger a warning.

Additionally, a warning will occur below 700 feet if a negative climb (sink) rate exceeds those rates as depicted below.

As the aircraft climbs through 700 feet AGL, Mode 3 is cancelled.





FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

GROUND PROXIMITY WARNING SYSTEM (GPWS) (cont'd.)

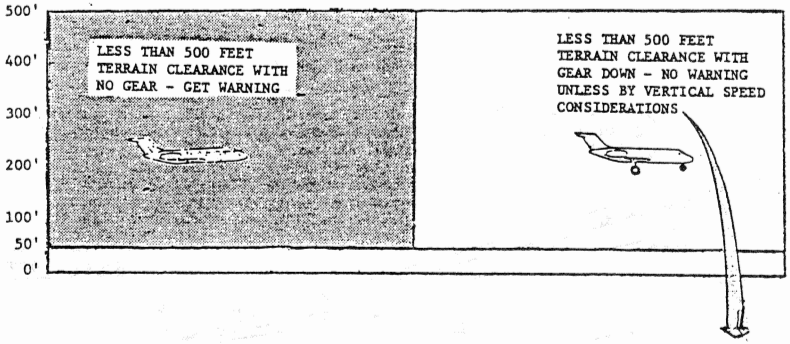
Mode 4: Inadvertent Proximity to Terrain During Approach

This mode becomes operational when the aircraft has climbed through 700 feet AGL following takeoff and will trigger a warning if the aircraft descends through 500 feet AGL with the landing gear lever not down, regardless of descent rate.

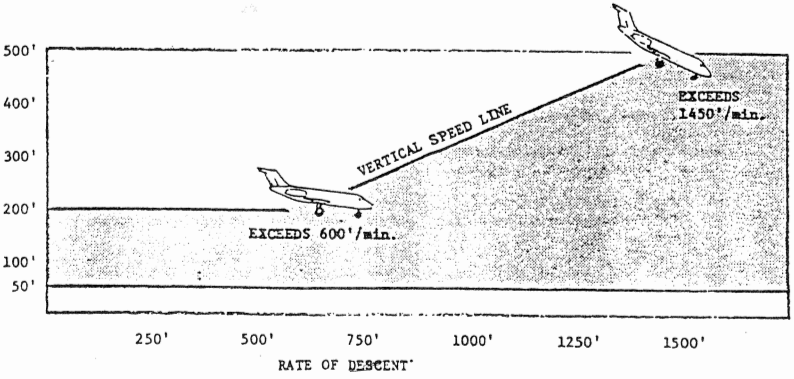
Additionally, a warning is triggered if the landing gear lever is down but flaps are not in the landing configuration and vertical speed exceeds those values shown below. However, if the aircraft descends below 200 feet AGL with the flaps set to less than landing, the warning will occur regardless of the rate of descent.

Mode 4 is cancelled and Mode 3 is activated when the flaps are moved out of the landing configuration and/or the gear lever is moved to the UP position, or upon landing (radio altimeter 0 feet).

MODE 4 - FLIGHT INTO TERRAIN WITH LESS THAN 500 FEET TERRAIN CLEARANCE


500'
400'
300'
200'
100'
50'
0'
LESS THAN 500 FEET TERRAIN CLEARANCE WITH NO GEAR - GET WARNING
LESS THAN 500 FEET TERRAIN CLEARANCE WITH GEAR DOWN - NO WARNING UNLESS BY VERTICAL SPEED CONSIDERATIONS

MODE 4 - VERTICAL SPEED CONSIDERATIONS WITH FLAPS NOT IN LANDING CONFIGURATION.



FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

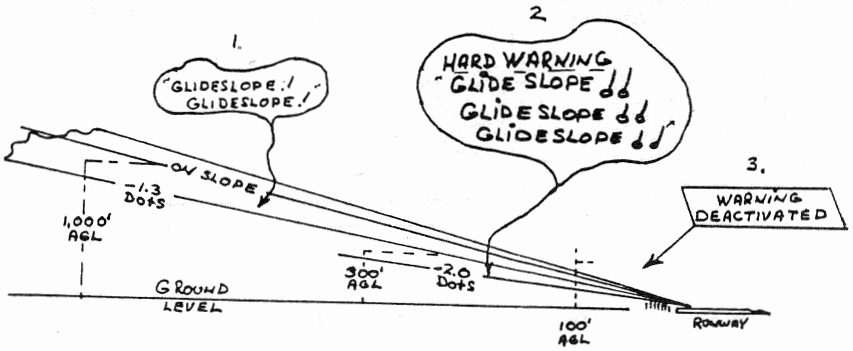
GROUND PROXIMITY WARNING SYSTEM (GPWS) (cont'd.)

Mode 5: Glideslope Deviation Alerting

This mode provides warning of critical below glideslope indication. It receives its information from the No. 1 NAV receiver and the radio altimeter.

Basically, deviation alerting is outlined as follows:

- Between approximately 1,000 and 300 feet AGL, any glideslope undershoot of approximately 1.3 dots or greater will activate both a visual and audio glideslope warning.
- Between approximately 300 and 100 feet AGL, any glideslope undershoot of approximately 2.0 dots or greater will activate both a visual and audio glideslope warning. The audio warning will be a "hard warning," consisting of an increased volume or hardness.
- Below approximately 100 feet AGL, both visual and audio glideslope warnings are deactivated. This will eliminate nuisance warnings at this low altitude.



FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

GROUND PROXIMITY WARNING SYSTEM (GPWS) (cont'd.)

Operation

Limitations

GPWS does not provide warning for landing short of the runway when aircraft is in landing configuration and descending at normal rates.

GPWS does not provide warning for approaching steep terrain such as a sheer cliff.

Approaches with unusual terrain, such as Charleston, Cincinnati, etc., may momentarily cause GPWS warnings.

Automatic Monitoring and Self-Test

Continuous automatic monitoring of the GPWS system inputs is provided to advise the flight crew of its operational status. A failure will illuminate the GPW fail annunciator light in the cockpit.

The GPWS automatic self-test cycle is initiated with application of electrial power when below 50 feet or above 2,450 feet radio altitude and with a barometric descent rate of less than 3,000 FPM.

If a failure occurs in the GPWS during the self-test cycle, the GPW fail annunciator light illuminates and the system becomes inoperative. If the fault clears during subsequent self-test cycles, the GPW fail annunciator will extinguish and the system becomes again operational.

Manual Self-Test

Manual self-test provides an operational preflight check of the GPWS. It is accomplished by depressing either forward instrument panel GPW Fail/GPW Test light caps. To complete the test, the following is required:

- Required electrical power must be on-line and both GPWS circuit breakers must be in.
- The radio altimeter must be operational indicating less than approximately 50 feet and not flagged out.
- The GPW Fail/GPW Test light caps must not be illuminated.

NOTE: The GPWS test can be accomplished on the ground only.

To accomplish the GPWS preflight check, depress the GPW Fail/GPW Test light cap for 2 to 3 seconds and release. The following should occur for a satisfactory preflight check:

- The GPW Fail/GPW Test light cap will illuminate red and remain illuminated for the complete check.
- The pull up warning light will illuminate red followed by the sound "WHOOP, WHOOP" and the spoken command "PULL UP."
- At the completion of the pull up cycle, the Below G/S--G/S Inhibit light cap will illuminate amber followed by the spoken warning "GLIDESLOPE."
- At the completion of the glideslope cycle, the GPW Fail/GPW Test light cap will extinguish.

(cont'd.)

FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

GROUND PROXIMITY WARNING SYSTEM (GPWS) (cont'd.)

Operation (cont'd.)

Manual Self-Test (cont'd.)

A satisfactory completion of the manual self-test indicates the following status of the GPWS:

- Aural and visual outputs are valid.
- Radio altimeter and BARO inputs are present.
- GPWS computer monitor has found no faults.
- INHIBIT status is valid.
- Radio altimeter validity, baro rate validity, and integrity monitoring has found no faults.
- Proper gear signal is present. (Not applicable for preflight check.)
- Flap signal indicates other than landing configuration or 26° flaps or greater. (Not applicable for preflight check.)

Localizer Backcourse Operations

Frequent nuisance GPW glideslope warnings occur during no glideslope localizer backcourse approaches. The left ILS front/backcourse switch is incorporated into the GPW glideslope warning mode. Any time the left ILS front/backcourse switch is selected to BACK course, the GPW glideslope deviation warning (Mode 5) is inhibited and will remain inhibited as long as the switch remains in the BACK course position.

For all normal no glideslope backcourse approaches, the left ILS front/backcourse switch should be selected to BACK.

FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

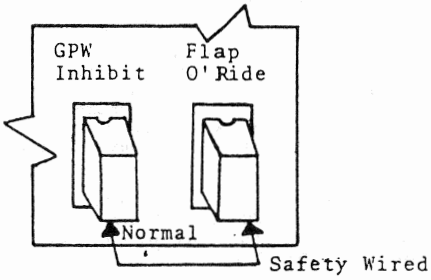
GROUND PROXIMITY WARNING SYSTEM (GPWS) (cont'd.)

Controls & Indicators

GPWS Inhibit Switch

The GPWS inhibit switch is located on the Captain's instrument panel. It prevents activation of the warning if a landing approach must be made in an abnormal configuration.

All GPWS modes are deactivated. Warning will not activate.



FLAP O'RIDE - Bypasses flap logic to computer if flaps cannot be extended to landing configuration. Warning will not activate if flap position logic would normally trigger it.

NORMAL ------ (Guarded) Assures all inputs are routed to the GPWS computer for normal system operation.

GPWS Aural Warning Speaker

A GPWS aural warning speaker is located in the left overhead ceiling area.

The aural warning consists of the sound "WHOOP, WHOOP" followed by the spoken command "PULL UP" or the spoken warning "GLIDESLOPE." Both the command and the warning will continue until the hazardous condition no longer exists. In addition, the hardness or volume of the glideslope warning will increase if the critical deviation from the glideslope continues or occurs below approximately 300 feet AGL.

FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

GROUND PROXIMITY WARNING SYSTEM (GPWS) (cont'd.)

Controls & Indicators (cont'd.)

Visual Warning Lights and Light Caps

Warning lights and light caps are installed on each pilot's forward instrument panel. There are three light/light caps on each panel. They consist of:

- PULL UP: The pull up warning light can be illuminated by one or more of the first four GPWS modes. It can also be illuminated through the self-test mode. The warning light will illuminate red followed by the sound "WHOOP, WHOOP" and the spoken command "PULL UP."

- BELOW G/S--G/S INHIBIT: The Below G/S light cap can be illuminated by GPWS Mode 5. It is an indication of a critical glideslope undershoot. It can also be illuminated through the self-test mode. The light cap will illuminate amber followed by the spoken command "GLIDESLOPE." The hardness or volume of the spoken command will increase if the critical deviation from the glideslope continues or occurs below approximately 300 feet AGL.

  In addition to providing a visual warning of critical glideslope undershoot, the Below G/S--G/S Inhibit light cap incorporates a push-to-inhibit or cancel nuisance below glideslope warnings caused by erroneous glideslope indications, backcourse glideslope indications, or planned deviations from glideslope as in the case of a no flap approach.

  When the light cap is depressed, the Below G/S warning will be inhibited or cancelled for the remainder of the approach. The warning mode will be rearmed when the GPWS receives a normal on glideslope or an above glideslope signal or until touchdown.

  NOTE: The left ILS front/backcourse switch will also inhibit or cancel Below G/S warnings.

  The G/S Inhibit feature of the Below G/S--G/S Inhibit light cap is not available on the right forward instrument panel GPWS lights.

  If a Below G/S warning occurs during an approach and the warning is inhibited through the G/S Inhibit light cap, the Below G/S--G/S Inhibit light cap will remain illuminated until the system is rearmed. If the warning is inhibited with the left ILS front/backcourse switch, the Below G/S--G/S Inhibit light cap will remain illuminated until the switch is positioned to FRONT course.

(cont'd.)

FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

GROUND PROXIMITY WARNING SYSTEM (GPWS) (cont'd.)

Controls & Indicators (cont'd.)

Visual Warning Lights and Light Caps (cont'd.)

- GPW FAIL/GPW TEST: The GPW fail warning light will illuminate red for any failure during the normal automatic monitoring and self-test mode and will normally be illuminated during the manual self-test mode.

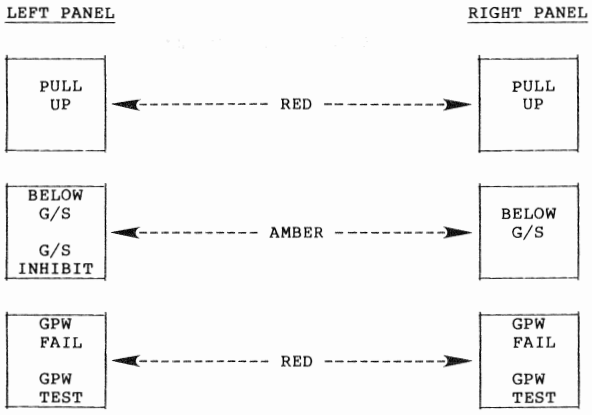
  The illuminated light cap can be extinguished by positioning the GPW inhibit switch from NORMAL to INHIBIT. It can also be extinguished by tripping GPW C/B's #459 and #462.

  In addition to providing a visual warning of a GPWS failure, the GPW Fail/GPW Test light cap incorporates a push-to-test feature. The GPWS manual self-test feature is operational on the ground only. When the light cap is depressed, the following should occur:

  - The GPW Fail/GPS Test light cap will illuminate red and remain illuminated for the complete test.

  - The pull up warning light will illuminate red followed by the sound "WHOOP, WHOOP" adn the spoken command "PULL UP."

  - The Below G/S--G/S Inhibit light cap will illuminate followed by the spoken command "GLIDESLOPE."



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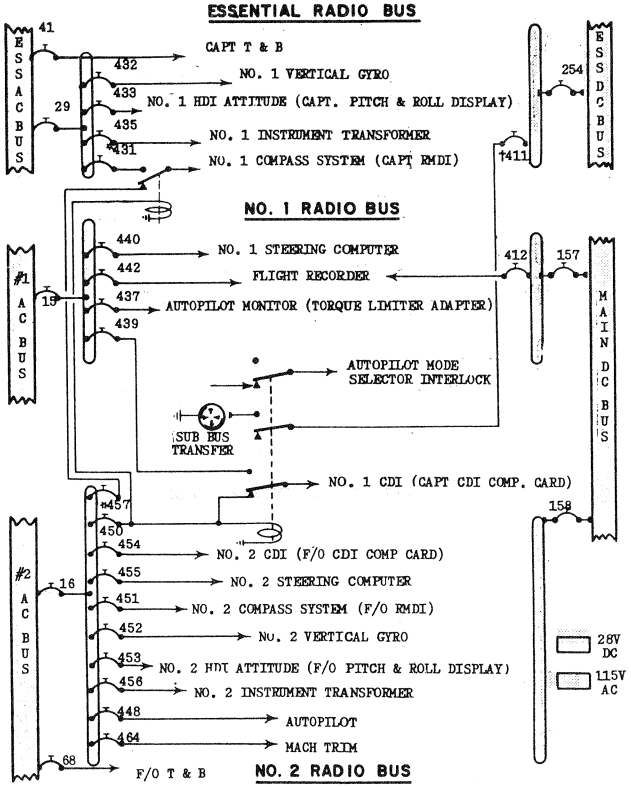
FLIGHT INSTRUMENTS SYSTEM DESCRIPTION

FLIGHT INSTRUMENT POWER DISTRIBUTION SCHEMATIC



NOTES: *1. No. 1 compass power circuit shown here is for airplanes having c-b 457 installed. On airplanes not having c-b 457 installed, No. 1 compass is powered directly from essential radio bus thru c-b 431.

2. Numbers above circuit breakers correspond to numbers engraved on circuit breaker panels.

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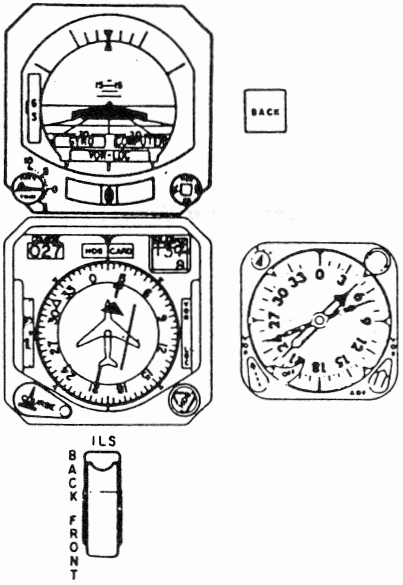
NAVIGATION SYSTEM DESCRIPTION

FLIGHT DIRECTOR SYSTEM

General Description

Two Collins FD-108 systems are installed. Each system has the following:

- its own steer computer.
- a vertical gyro (with provisions for bootstrapping from opposite V.G.).
- an HDI.
- a CDI.



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NAVIGATION SYSTEM DESCRIPTION

COURSE DEVIATION INDICATOR (CDI)

General

The CDI indicates:

- Magnetic heading on a rotating compass card.
- Deviation from a selected VOR radial or localizer course.
- Displacement from a selected glideslope beam.

Operation

To Use on VOR

Select desired radial on VOR station to which the respective (No. 1 and No. 2) VHF NAV receiver is tuned. The CDI will pictorially display the aircraft position relative to the selected radial. This CDI pictorial display will be correct on a VOR even though the reciprocal of the desired radial is set in the CDI. For example, if flying inbound on the 225° radial or outbound on the 45° radial, the CDI pictorial display, including the "to" flag indication, will be correct even though 225 is selected in the CDI. (HDI indications will be reversed with back/front switch in FRONT if the reciprocal is selected as described later.)

To Use on ILS Localizer

Always select the published frontcourse inbound magnetic course of the localizer, whether making a frontcourse approach or a backcourse approach. If this is done, the CDI pictorial display will always be correct. The "to-from" flags are not operative on a localizer since the ground facility does not transmit a signal from which the airborne equipment can derive "to-from" intelligence.

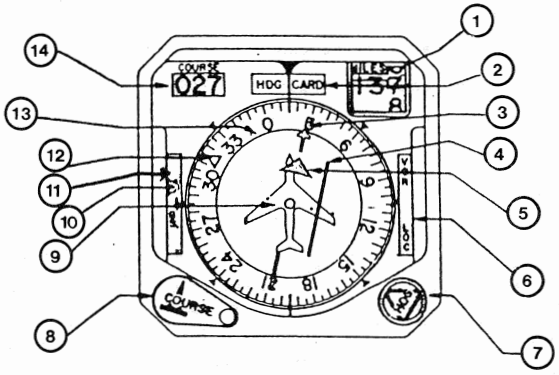
NOTE: Course and Heading selectors on both CDI's are also used to set desired information for respective flight steering computer. In addition, selectors on Captain's CDI are used in conjunction with autopilot.

Supplied by Jeppesen Sanderson

NAVIGATION SYSTEM DESCRIPTION

COURSE DEVIATION INDICATOR (CDI) (cont'd.)

Controls & Indicators



(1) DME Distance Display

Displays DME range on digital counters, but only the Captain's integral indicator is active. The F/O has a separate DME indicator on his/her panel which displays the same information.

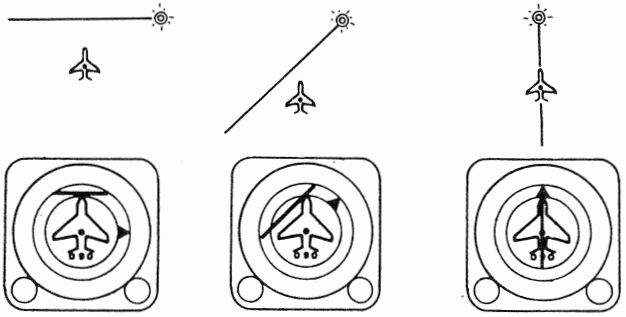
(2) Compass Flag

Monitors operation of the respective CDI compass card, operation of the instrument amplifier for the respective CDI, and agreement between the CDI compass information. If the HDG CARD flag appears, selecting an alternate compass signal source with the CDI select switch may restore CDI card operation.

(3) Course Cursor

(4) Course Deviation Bar

The bar is attached to a carriage which rotates around the fixed airplane reference whenever aircraft heading is changed or a new course is selected, giving a true picture of the aircraft in relation to a selected VOR or ILS course (left-right deviation) as shown below.



NAVIGATION SYSTEM DESCRIPTION

COURSE DEVIATION INDICATOR (CDI) (cont'd.)

Controls & Indicators (cont'd.)

(4) Course Deviation Bar (cont'd.)

When the corresponding VHF NAV radio is tuned to a VOR, the display will be true whether an inbound or a reciprocal course has been selected; e.g., when flying a 090° radial, either 090° or 270° may be selected with the course crank without changing the correctness of the display of the fixed aircraft symbol relative to the course deviation bar.

When tuned to an ILS, the frontcourse heading must always be selected to keep the pictorial display correct, regardless of whether the airplane is on the front or back side and regardless of its direction of flight.

If the rotating compass card becomes inoperative, the course deviation bar may still be used as a straight left-right indicator.

(5) To/From Indicator

This indicator is a solid triangular flag mounted on the deviation bar carriage. The indicator points in the direction of a selected VOR station (station ahead or behind the aircraft) regardless of aircraft heading. The indicator will not appear when tuned to a localizer.

(6) VOR/LOC Warning Flag

Appears on the CDI when the VOR or localizer signal from the respective VHF NAV receiver is unusable.

(7) CDI Heading Knob

Knob is used (in HDI HDG mode only) to set a desired magnetic heading for the steer computer so that the steer computer may supply command signals to the HDI steering "V" bars. Turning the knob moves the yellow hollow triangle heading cursor to the desired heading. This "set-in" heading is also supplied to the autopilot from the Captain's CDI only. The heading cursor rotates with the compass card.

(8) CDI Course Crank

Used to set a desired VOR radial or localizer course heading in the course counter window. It also rotates the deviation bar carriage to the desired course. An arrow course cursor indicates the selected course.

(9) Airplane Reference Symbol

Fixed to the face of the instrument.

(10) Glideslope Pointer

Displays glideslope displacement. Each glideslope bar receives signals directly from its respective glideslope receiver; there are no provisions for crossfeeding glideslope signals.

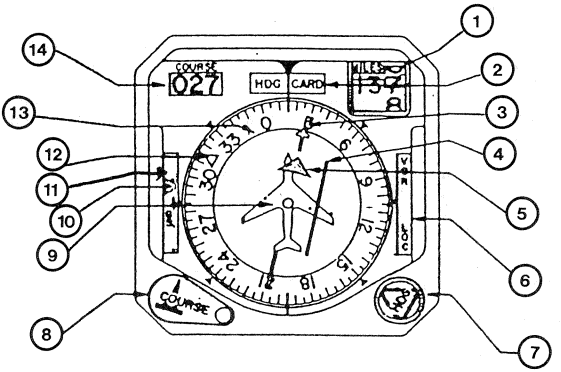
(cont'd.)

Supplied by Jeppesen Sanderson

NAVIGATION SYSTEM DESCRIPTION

COURSE DEVIATION INDICATOR (CDI) (cont'd.)

Controls & Indicators (cont'd.)



(11) GS Warning Flag

Covers the entire glideslope display when tuned to an ILS frequency and the glideslope signal is OFF, too weak, etc. However, as in all glideslope systems, the flag will not appear for all malfunctions that could render glideslope indications unreliable. For this reason, proper glideslope operation should always be verified by crosschecking the two instruments and by checking the marker crossing altitudes during an ILS approach.

(12) Heading Cursor

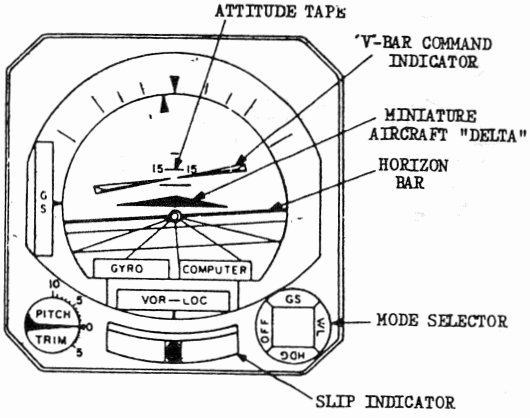
(13) Rotating Compass Card

Repeats an RMDI as described under COMPASS SYSTEM in this chapter. Magnetic heading is read under a fixed pointer at the top of the instrument.

(14) Course Counter

NAVIGATION SYSTEM DESCRIPTION

HORIZON DIRECTOR INDICATOR (HDI)



HDI Inputs

- Pitch and roll signals from a remotely located vertical gyro (as selected by the HDI select switch).
- Steer commands from its steering computer (except in OFF mode).
- VOR and localizer/glideslope deviation signals from its respective VHF NAV receiver.

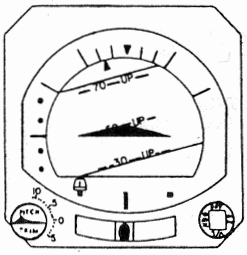
HDI Readouts

- Aircraft Attitude. Shows relationship of a fixed delta-shaped airplane symbol to a gyro actuated (pitch & roll) sky-ground tape. (Pitch trim knob manually adjusts attitude tape from 10° up to 5° down.)
- Steer commands, as ordered by steer-computer actuated V-bar.
- Localizer/VOR Displacement:
  - Straight left/right deviation (raw VHF NAV data), and
  - V-bar commands to capture and track a preselected course on a VHF NAV facility. (VHF NAV signal modified by steer computer.)
- Glideslope Displacement:
  - Glideslope pointer (raw VHF NAV data - repeats CDI GS pointer), and
  - V-bar pitch commands.

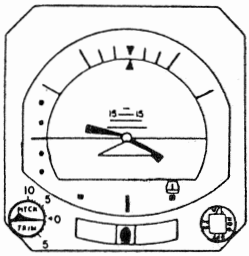
NAVIGATION SYSTEM DESCRIPTION

HORIZON DIRECTOR INDICATOR (HDI) (cont'd.)

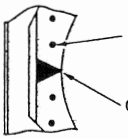
HDI Readouts (cont'd.)

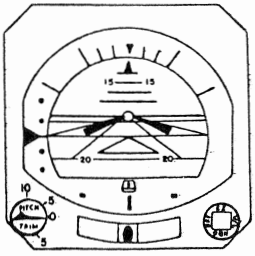


This illustration shows airplane 50° nose up, 18° right bank; to the right of selected course.



This illustration shows airplane wings level, V-bars commanding a 30° right bank; to the left of selected course.





This illustration shows airplane wings level, nose down 10°, V-bars commanding level flight; on selected course.

NAVIGATION SYSTEM DESCRIPTION

HORIZON DIRECTOR INDICATOR (HDI) (cont'd.)

Operation

Attitude Display Pitch Trim

Adjust desired pitch trim with knob in lower left corner of HDI. When knob is turned, horizon bar will move up or down in relation to fixed delta-shaped symbol of airplane. (Adjustable from +10° to -5°.)

VOR or Localizer Deviation Indications

Straight deviation is displayed by the VOR/LOC deviation pointer at bottom of HDI. The pointer in each HDI operates on signals received from the respective No. 1 or No. 2 VHF NAV receiver. On a VOR, desired radial must be set in the respective CDI. On localizer, the localizer course should be set in CDI, even though it does not have to be for proper operation of HDI deviation bar itself. (For proper operation of CDI, localizer course must be set in CDI.)

One dot displacement of deviation bar in HDI (full scale) is equal to one dot displacement of bar in CDI (half scale).

Back/front switch on each (Captain's and F/O's) panel reverses signal to deviation bar in respective HDI.

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NAVIGATION SYSTEM DESCRIPTION

VERTICAL GYROS

General

Two vertical gyros (No. 1 and No. 2) are installed in the E & E compartment. When their AC motors are energized they receive extra power to spin them up to speed (fast erection mode) until within 5° of level, then go into slow erection mode (about 2° erection per minute) until level. The gyro flag will appear in the respective HDI during the fast erection cycle and will remain in view until all operating conditions are satisfied (up to 3 minutes after power is applied).

Controls & Indicators

HDI Select Switch

The HDI select switch is located on the center instrument panel and has CAPT ON ALT-NORM-F/O ON ALT positions. It operates a transfer relay which causes the HDI selected to repeat the attitude indications from the other HDI. The transfer relay is powered by the ESS DC radio bus. Should power be lost, the relay will remain in its last position.

Gyro Warning Flag

The gyro warning flag in lower left of each HDI monitors the attitude system. The flag will appear unless all of the following conditions are satisfied:

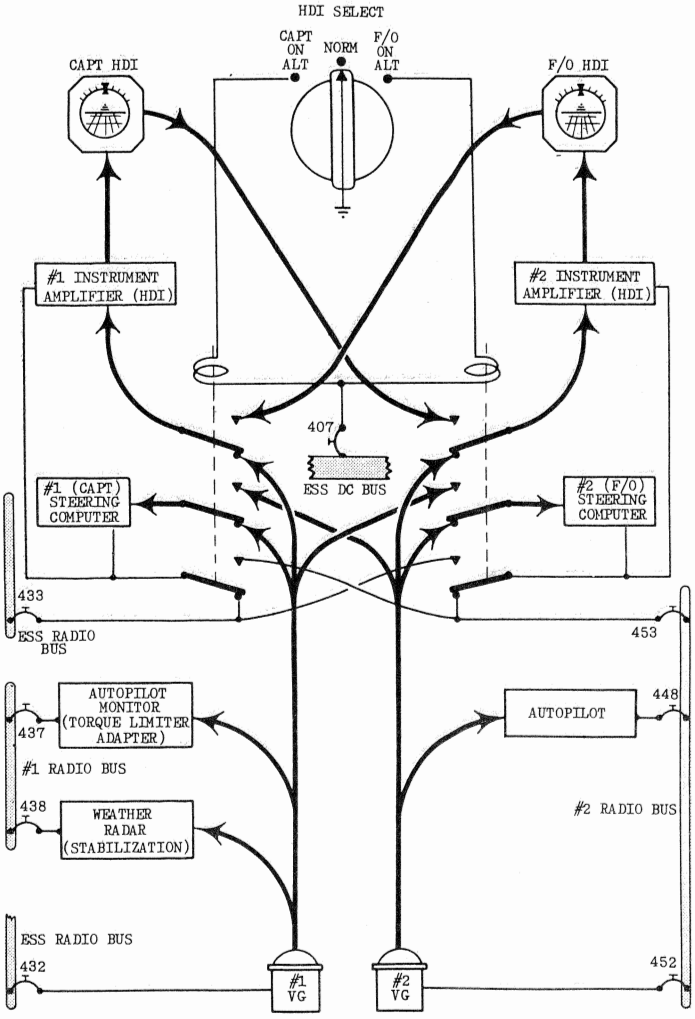
- Power to the respective vertical gyro and not in fast erection cycle.
- Power to the respective instrument amplifier.
- Aircraft attitude, as displayed on the HDI, is within 7° in pitch and roll of attitude sensed by the vertical gyro.

When an HDI is switched to an alternate signal source, the gyro flag becomes a function of the new signal source and monitors it as in the normal position.

NAVIGATION SYSTEM DESCRIPTION

VERTICAL GYROS (cont'd.)

Vertical Gyro Signal Chain Schematic



NOTE: Numbers above circuit breakers correspond to numbers engraved on circuit breaker panel.

——115V AC ——28V DC

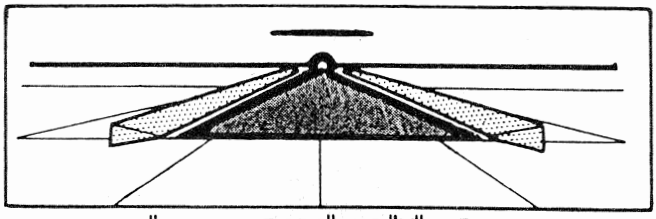
NAVIGATION SYSTEM DESCRIPTION

STEER COMPUTERS

General Description

Each HDI has a steer computer which furnishes an input to the V-bars as determined by the position of the mode selector knob. The V-bars present computed steer commands to indicate bank and pitch attitudes necessary to execute selected maneuvers.

HDI V-Bar Deviation/Steer Display



"DESIGN ZERO" OF "V"BAR

NOTE: The following HDI displays are independent of HDI mode and of V-bar display:

- Aircraft attitude.
- Deviation bar display of VOR/localizer deviation.
- Glideslope pointer display of glideslope deviation.

HDI displays VOR/localizer deviation or steering commands, depending on mode.

OFF - V-bar electrically held from view.

HDG - V-bar displays steer commands to turn toward a magnetic heading selected by HDG knob on CDI. Sequence is:

- Computer computes commands from difference between actual aircraft heading and preset CDI heading.

(cont'd.)

NAVIGATION SYSTEM DESCRIPTION

STEER COMPUTERS (cont'd.)

HDI V-Bar Deviation/Steer Display (cont'd.)

HDG (cont'd.)

- Tilts V-bar (about 30° max.) to command turn.
- Aircraft rolls into bank (delta flown into V-bar).
- V-bar moves back towards design zero (reading design zero when computed bank is reached).
- If aircraft banks beyond commanded bank, V-bar deflects proportionally to other side of design zero.
- The closer the aircraft comes to preset heading, the smaller the commanded bank becomes, so roll-out is smooth.

V/L - V-bar gives commands to capture and/or track a tuned VOR or localizer. Function is:

- Computer compares existing aircraft heading, selected course (course crank), and VHF NAV displacement from selected course.
- Computes resultant heading to capture or track selected course.
- V-bar commands aircraft to turn to computed heading.
- As aircraft obeys command, V-bar returns to design zero.
- If aircraft maintains computed bank (which gets smaller as selected course is approached), V-bar remains at design zero for an eventual smooth roll-out onto course.

NOTE: For the V-bar to show a FLY TO display, the localizer inbound frontcourse must be selected.

If a backcourse ILS approach is made and it is desired to fly to the V-bar, front inbound course must be selected and back/front switch placed in BACK position.

(cont'd.)

NAVIGATION SYSTEM DESCRIPTION

STEER COMPUTERS (cont'd.)

HDI V-Bar Deviation/Steer Display (cont'd.)

GS - V-bar capture and tracking of VOR/localizer course is as described under V/L mode. In GS, the V-bar additionally commands computed pitch changes to maintain glideslope after glideslope interception. Sequence is (in addition to V/L mode sequence):

- Annunciator shows ARMED when tuned ILS is being received but before glideslope has been intercepted.
- Annunciator shows engaged and V-bar commands pitch to track glideslope upon glideslope interception. Bank commands are continued.
- Upon crossing middle marker, V-bar sensitivity to glideslope signal is reduced by about 50%.

NAVIGATION SYSTEM DESCRIPTION

STEER COMPUTERS (cont'd.)

Controls & Indicators

ILS Back/Front Switches

ILS back/front switches, one below each CDI, are guarded to the FRONT position. In the BACK position, VOR or localizer displacement signals to the respective HDI V-bars and the VOR/LOC deviation pointer are reversed. This provides indications such that the aircraft will always be turned toward the "V" or VOR/LOC deviation pointer to get on course. The back/front switch has no affect on HDI V-bar indication in HDG mode and never has any affect on the CDI.

If the autopilot mode selector is in the V/L or G/S positions, it automatically returns to MAN if the Captain's back/front switch is placed to BACK.

A BACK annunciator light above the altimeter on each pilots' panel illuminates whenever the respective ILS back/front switch is positioned to BACK.

HDI Glideslope Display

A glideslope pointer on the left side of each HDI displays glideslope displacement. The pointer operates on signals from the respective glideslope receiver (no provision for crossfeeding signals) when a localizer frequency is tuned on the respective VHF NAV receiver.

- HDI GS Warning Flag - Covers the glideslope scale and bar when an ILS frequency is selected if the glideslope is OFF, too weak, etc.

- HDI Computer Flag - Monitors power to steer computer and inputs to it.

HDI Lateral Display (VOR/Localizer)

This indicator displays left/right deviation from VOR radial or ILS course.

- HDI VOR/LOC Flag - Appears when no localizer or VOR signal, signal too weak, etc.

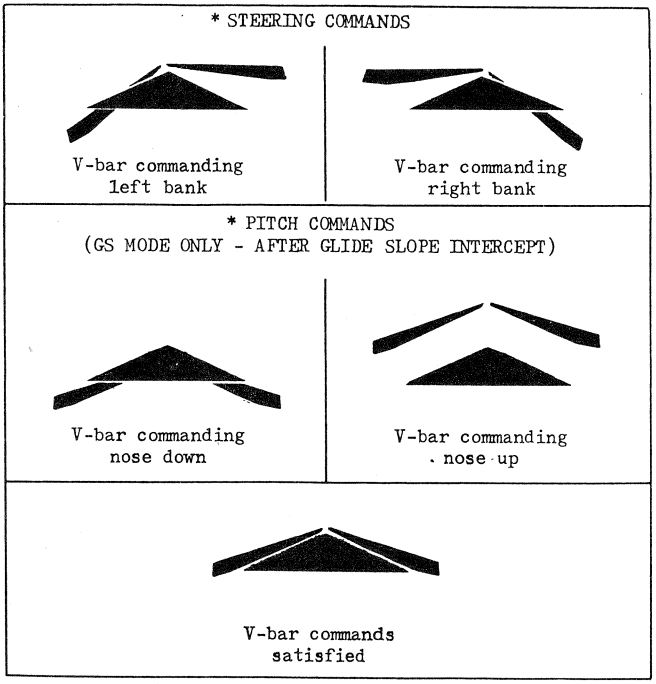
NAVIGATION SYSTEM DESCRIPTION

STEER COMPUTERS (cont'd.)

Operation

Flight Steering Computer Inputs to HDI

Steering computer inputs to HDI are displayed by V-bar on HDI. To utilize steering computer command guidance, airplane is flown to keep delta-shaped symbol of airplane in proper relationship to V-bar; relationship of V-bar to delta for command guidance is shown in diagram below.


* STEERING COMMANDS
V-bar commanding left bank
V-bar commanding right bank
* PITCH COMMANDS
(GS MODE ONLY - AFTER GLIDE SLOPE INTERCEPT)
V-bar commanding nose down
V-bar commanding nose up
V-bar commands satisfied

* V-bar is locked to delta in pitch and does not give pitch commands except in GS mode after glideslope intercept.

(cont'd.)

NAVIGATION SYSTEM DESCRIPTION

STEER COMPUTERS (cont'd.)

Operation (cont'd.)

Flight Steering Computer Inputs to HDI (cont'd.)

Mode of steering computer is selected by selector in lower right corner of instrument. When selector is in OFF position, V-bar is pulled back out of sight leaving only the basic attitude display. Other modes of computer are used as follows:

NOTE: Do not use either steering computer when HDI select switch (bootstrap switch) is out of the NORMAL position; this can cause V-bars to command bank angles in excess of normal limits.

- To Use HDG Mode

1. Set desired heading in respective CDI (using HDG knob).

2. Set HDI mode selector to HDG.

3. V-bar will command proper bank angle (up to 30° max.) to turn airplane to preset magnetic heading. By keeping delta in proper relationship to V-bar, airplane will turn toward and roll-out smoothly on selected heading.

- To Use V/L (VOR/Localizer) Mode

1. Tune respective VHF NAV receiver to desired ground facility (VOR or localizer).

2. Select desired course in respective CDI (using course selector). If being used for localizer, select localizer frontcourse inbound heading.

3. Place HDI mode selector to V/L.

4. Fly airplane so as to keep delta in proper relationship to V-bar. V-bar will provide steering command guidance as follows:

   - If airplane is outside "edge of beam" (2 dots CDI bar displacement on localizer, 1 dot on VOR), V-bar will command bank angle needed (up to 30° max.) to establish 45° intercept of selected course.

   - When "edge of beam" is reached, or if already inside this point when V/L is selected, V-bar will command bank angle needed (up to 30° max.) to actually capture course center line.

- To Use GS Mode

1. Follow steps 1 through 4 for V/L mode (given above), except select GS mode in step 3.

2. Upon intercepting glideslope, V-bar will command proper airplane pitch attitude required to track glideslope (while continuing to command bank angle required to track localizer). As above, fly airplane so as to keep delta-shaped symbol aligned with V-bar.

3. When using GS mode, check steering computer annunciator during approach as this indicates proper switching of computer circuits for correct glideslope command guidance. Annunciator should move from OFF to ARM when airplane reaches a point about 2-1/2° from localizer center line (2 dots on CDI bar). It should move from ARM to ENG upon intercepting glideslope. If annunciator does not function in this manner, disregard V-bar pitch commands.

(cont'd.)

NAVIGATION SYSTEM DESCRIPTION

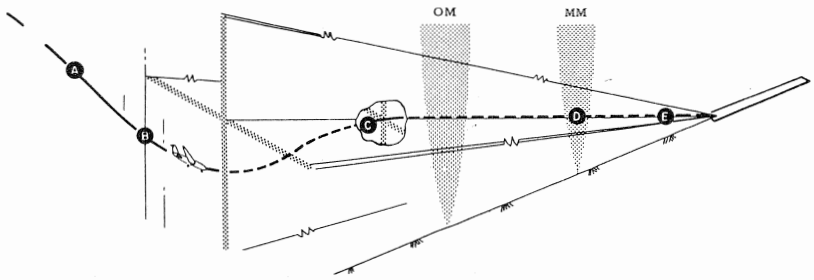
STEER COMPUTERS (cont'd.)

Operation (cont'd.)

Flight Steering Computer Inputs to HDI (cont'd.)

The preceding procedures outline the steps required to use each of the steering computer modes in its entirety. For specific recommendation on the use of various modes during an ILS approach, refer to the following diagram.

Recommended Use of Steering Computer for ILS Approach



(A) Outside edge of beam (2 dot displacement of CDI bar), place mode selector on HDI to HDG. Set heading(s) needed to intercept localizer on CDI and fly V-bar bank commands until intercepting edge of beam. (Max. bank command is 30°.)

NOTE: Always monitor localizer and glideslope raw data indications on HDI during approach to assure integrity of steering computer command guidance.

(B) At edge of beam, place mode selector on HDI to GS. Check that flight director glideslope annunciator shows ARM. Fly V-bar bank commands to capture and track localizer. (Max. bank command is 30°; V-bar gives no pitch commands at this time.)

(C) Intercepting glideslope, check that annunciator moves to ENG. Fly V-bar pitch commands to capture and track glideslope and continue to fly bank commands to track localizer. (Max. bank command is 15°; max. pitch command is 12°.)

CAUTION: If annunciator does not move to ENG, disregard V-bar pitch commands.

(D) Crossing middle marker, continue to fly V-bar commands to track localizer and glideslope. (V-bar sensitivity to glideslope signals reduced by about 50% at this time.)

(E) Go around, if required. Set HDI mode selector to OFF.

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NAVIGATION SYSTEM DESCRIPTION

COMPASS SYSTEM

There are two complete and independent gyro flux gate compass systems, one for the Captain and one for the F/O. The basic design concept of these systems is to retain the advantages and desirable features of both the straight directional gyro and the straight magnetic compass while eliminating the undesirable features of both. Each compass system consists of four major components:

- Flux valve compass transmitter located in wing tip (Captain - left, F/O - right).
- Directional gyro transmitter located in the E & E compartment.
- Compass amplifier located in the radio rack.
- Radio magnetic direction indicator located on each pilot's instrument panel.

The purpose of the flux valve transmitter is to sense the orientation of the aircraft in the earth's magnetic field, i.e., aircraft heading relative to the earth's magnetic poles. The purpose of the directional gyro is to provide the stability inherent in a straight directional DG.

The compass amplifier combines the signals from the flux valve compass transmitter and the directional gyro transmitter and supplies a signal to the respective RMDI. The system readout in the RMDI consists of a basic DG signal which is slaved to and corrected by the flux gate transmitter signal. If the two signals are not synchronized (which would mean that the RMDI would not be indicating the correct magnetic heading), a signal is generated to slave the RMDI.

The F/O's directional gyro transmitter supplies heading information to the autopilot for operation in the MANUAL mode. Heading information for all other modes of autopilot operation is supplied by the signal which drives the azimuth card of the Captain's CDI.

Each compass system drives the respective (Captain's or F/O's) RMDI azimuth card. The Captain's CDI azimuth card is supplied heading information from the F/O's RMDI; the F/O's CDI azimuth card repeats heading information from the Captain's RMDI. A CDI select switch, located on the center instrument panel, permits switching the CDI of a failed system to repeat signals from the operative compass system's RMDI.

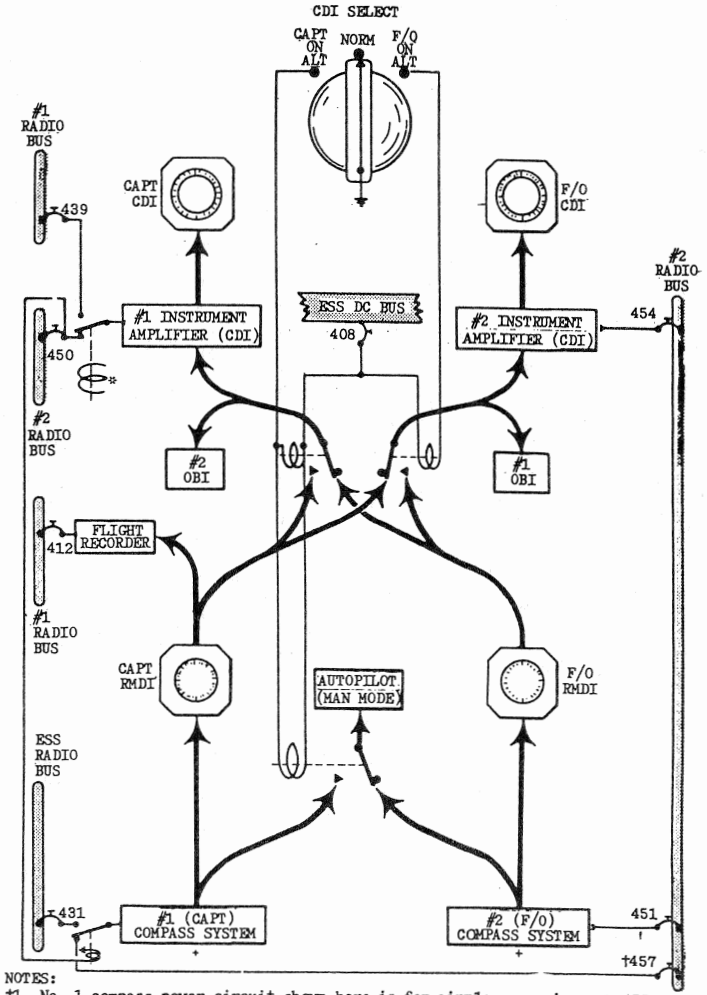
There are two variations of the Captain's compass system power supply:

- If C/B #457 is installed, the Captain's compass system receives AC power from the No. 2 radio bus. Should ths power source fail, a sub-bus transfer relay will automatically transfer the Captain's compass system to the ESS radio bus. Additionally, the sub-bus transfer light on the Captain's instrument panel will illuminate.
- If C/B #457 is not installed, the Captain's compass system receives AC power from the ESS radio bus, through the No. 1 compass system C/B #431. This arrangement does not provide switching capability in the event of power failure.

NAVIGATION SYSTEM DESCRIPTION

COMPASS SYSTEM (cont'd.)

Signal Chain Schematic



NOTES:

†1. No. 1 compass power circuit shown here is for airplanes having c-b 457 installed. On airplanes not having c-b 457 installed, No. 1 compass is powered directly from essential radio bus thru c-b 431.

*2. Sub Bus Transfer Relay—see Flight Instrument Power Distribution schematic.

3. Numbers above circuit breakers correspond to numbers engraved on circuit breaker panels.

115V AC 28V DC

NAVIGATION SYSTEM DESCRIPTION

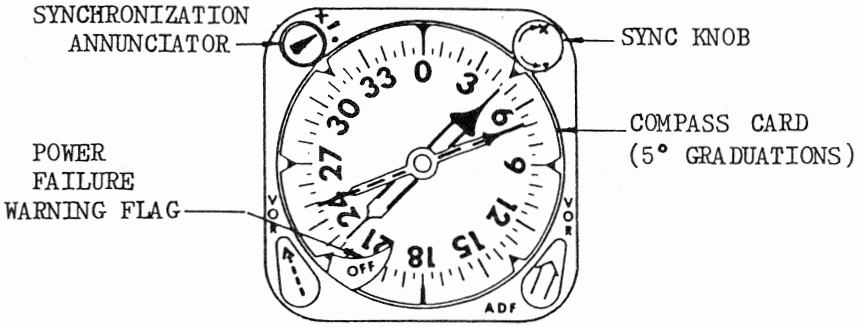
RADIO MAGNETIC DIRECTIONAL INDICATOR (RMDI)

General Description

One RMDI is located on each pilot's instrument panel and normally display a readout of its compass system on a rotating compass card. Each RMDI provides two modes of operation as follows:

- In the slaved heading mode, the RMDI receives a signal from the compass amplifier which is a DG signal slaved to the flux gate.
- In the free gyro mode, the flux valve transmitter is disconnected from the system. Free of magnetic heading signals, the directional gyro operates as a free gyro subject to precession of about 5° per hour.

Controls & Indicators



Synchronization Annunciator

Provides an indication as to whether the DG is fully slaved to the flux valve. (DG oriented so it indicates magnetic heading of the airplane.) If the DG is fully slaved, the pointer in the annunciator window will be aligned with the index. If it is not properly oriented, the pointer will be deflected towards the dot (.) or cross (+). If power is lost to the slaving portion of the compass system, the pointer will align with the index.

Synchronizing Knob

Used to manually reset the RMDI compass card. This is accomplished by depressing the sync knob and rotating it until the annunciator pointer aligns with the index.

NOTE: After manually resetting, the heading indicated on the RMDI card should be checked against a known reference (such as the standby compass or runway heading) since it is possible for the annunciator to show alignment with a difference of 180° existing between the flux valve transmitter and the RMDI compass card.

(cont'd.)

NAVIGATION SYSTEM DESCRIPTION

RADIO MAGNETIC DIRECTIONAL INDICATOR (RMDI) (cont'd.)

Controls & Indicators (cont'd.)

ADF/VOR Selector Knobs

These select the navigational radio bearing information to be displayed by the indicator needle.

The right knob (with double needle markings) can be turned to VOR or ADF positions. In the ADF position, it selects a directional input from the ADF receiver for the double needle. In the VOR position, it selects a directional input from the No. 2 VOR receiver for the double needle.

The left knob (with dashed single needle marking) normally is left in the VOR position where it selects a directional input from the No. 1 VOR receiver for the single needle.

Single Needle

Displays a radio magnetic directional signal from the No. 1 VOR receiver when the left ADF/VOR selector knob is in the VOR position. When the selector knob is in the unmarked position, there is no input to the single needle and it may rotate freely.

Double Needle

Displays a directional signal from the ADF when the right ADF/VOR selector knob is in the ADF position and displays a directional signal from the No. 2 VOR when the selector knob is in the VOR position.

RMDI Warning Flag

The OFF flag in each RMDI monitors power to the servo amplifier, the DG, the RMDI, and the slaving function. Should the OFF flag appear, the RMDI will not indicate DG heading even though the DG is operating properly.

RMI Mode Switches

RMI mode switches have FREE GYRO and SLAVED HDG position. Each switch is normally guarded to the SLAVED HDG position for operation of the respective RMDI in the slaved mode. When the switch is in the FREE GYRO position, the RMDI is operated as a free DG with the flux valve transmitter disconnected from the system.

Operation

NOTE: It will not always be possible to properly check the compass systems at the gate because the flux valves in the wing tips are easily influenced by fueling equipment, ground service trucks, etc. When these errors are observed, compass system accuracy must be checked after leaving the gate.

Slaved Mode

To operate system as a slaved directional gyro, the normal mode of operation, place RMI mode switch in SLAVED HDG position.

(cont'd.)

NAVIGATION SYSTEM DESCRIPTION

RADIO MAGNETIC DIRECTIONAL INDICATOR (RMDI) (cont'd.)

Operation (cont'd.)

To Initially Set RMDI Card

To initially set RMDI card to correct magnetic heading, that is to initially synchronize system, push in knob on upper right side of RMDI and rotate direction called for by synchronization indicator (+ or -) in upper left side of RMDI. Rotate knob until card reads correct magnetic heading and sync indicator pointer aligns with index line, then release knob.

NOTE: It is possible to synchronize the directional gyro 180° off the flux gate transmitter. Always check that the RMI card reads the correct magnetic heading.

CAUTION: In flight, whenever manually synchronizing RMDI supplying Captain's CDI, autopilot should be in MAN mode or OFF.

Ground Check Procedures

Ground check of the compass system to assure satisfactory operation prior to release of the aircraft for flight is essentially a maintenance responsibility. Maintenance has comprehensive checks on this system which are performed on scheduled frequencies. Following are condensed check procedures which are to be used by the flight crew at their discretion. Normally flight crew checks are only required if unsatisfactory operation is suspected or if maintenance is performed by other than AA maintenance personnel.

To Check Automatic Slaving of System

Push in on knob in upper right corner of RMDI and rotate the RMDI card a few degrees off heading in either direction, then release the mode knob. Check that the RMDI card automatically slaves back to the correct magnetic heading (at a rate of about 3° per minute) and that the synchronization indicator shows the direction of required slaving until the card returns to the correct magnetic heading, at which time the synchronization indicator pointer should align with index.

To Check CDI Cards as Repeaters of RMDI Cards

- With CDI select switch in NORMAL, push in knob on RMDI and rotate in either direction, noting that only opposite CDI card rotates with RMDI card.

- With CDI select switch in CAPT ON ALT, push in knob on Captain's RMDI and rotate in either direction, noting that both CDI cards rotate with Captain's RMDI.

- With CDI select switch in F/O ON ALT, push in knob on F/O's RMDI and rotate in either direction, noting that both CDI cards rotate with F/O's RMDI.

This check can be made along with check of automatic slaving given above; return switch to NORMAL after completing check.

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NAVIGATION SYSTEM DESCRIPTION

VERTICAL SCALE RADIO ALTIMETER

General Description

Two vertical scale radio altimeter indicators are installed as part of the Category II modification; one on the Captain's and one on the F/O's instrument panel. Both indicators are connected to one transmitter/receiver unit. These indicators provide accurate and reliable aircraft altitude above the terrain.

Aircraft altitude up to 2,500 feet is displayed by the movement of a calibrated tape against a stationary aircraft reference. The calibrated scale disappears behind the lower instrument case when the altitude is greater than the instruments range, leaving only a black tape in view.

Operation

The radio altimeter should be tested before starting engines and before beginning approach (above 2,500 feet) as follows:

CAUTION: Radio altimeter readout may vary considerably from barometric readouts because it is measuring actual height above terrain.

Ground Check

NOTE: Testing one indicator checks unit and both indicators.

- Set/Test Knob - ROTATE DOWN THRU "0". Check DH light illuminated when bug and counter are above "0". Reset below "0" to extinguish light.

- Set/Test Knob - DEPRESS. Check that altimeter reads 100 $\pm$ 5 feet and yellow flag drops.

Before Commencing Approach

- Set/Test Knob - DEPRESS.

- Decision Height Bug - SET.

Descending Through 2,500 Feet Above Terrain

Check that radio altimeter tape shows movement and DH light illuminated; reset light.

Descending Through 1,000 Feet Above Terrain

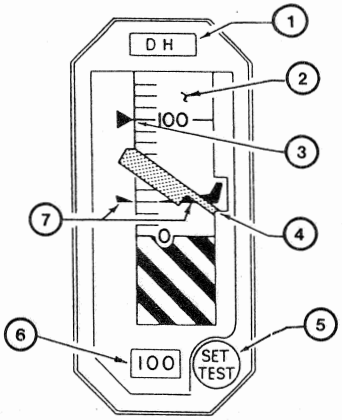
Check DH light illuminated (press light cap to extinguish).

NOTE: During coupled approach with radio altimeter operative, desensitization of the autopilot begins at 1,500 feet AGL radio altitude. If radio altimeter is inoperative, desensitization is triggered when crossing the outermarker.

NAVIGATION SYSTEM DESCRIPTION

VERTICAL SCALE RADIO ALTIMETER (cont'd.)

Controls & Indicators



(1) Decision Height Light (Amber)

Illuminates as the aircraft descends through two fixed settings, 2,500 feet and 1,000 feet, and a pilot selected altitude (from 0 to 499 feet). Depressing light cap will extinguish light, except when aircraft is below pilot selected altitude.

(2) Movable Altitude Tape (Multi-Colored)

(3) Decision Height Bug

Mechanically positioned by set/test knob to altitude indicated in counter window; it travels with altitude tape.

(4) Warning Flag (Yellow)

Appears during test or when a malfunction occurs.

(5) Set/Test Knob

Rotated to select desired decision height in counter window and simultaneously position DH bug. Depressing the knob positions altitude tape to a preset test altitude and the warning flag should appear. Either instrument can be tested; opposite instrument acts as a repeater.

(6) Counter Window (0 - 499 feet)

(7) Altitude Reference Marks (Fixed - Orange)

Indicate to height above the terrain.

NAVIGATION SYSTEM DESCRIPTION

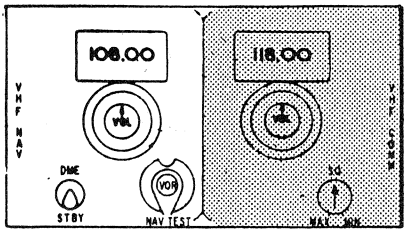
VHF NAVIGATION SYSTEMS

General Description

The airplane is equipped with two completely independent VHF navigation receivers, each consisting of a VOR and LOC/GS receiver and a control panel. A blade-type VOR/LOC antenna is located on either side of the vertical stabilizer. Both systems are completely transistorized and require only DC power. The VOR navigation systems provide the Captain and F/O with radio aids to navigation in the very high frequency (VHF) range between 108.0 and 117.7 mc. The radio information received is visually displayed on the pilot's instrument panels on the RMDI, CDI, and HDI. Provisions are made for aural reception of VOR station identification and voice reception.

The VOR navigation system control panels are located on the pedestal. Each panel has conventional frequency selector and volume control knobs. A rotary NAV TEST switch on the panel permits checking of HDI VOR/LOC deviation pointer, V-bar (bank only), GS pointers, and CDI deviation bar. A VOR test button, located in the center of the NAV TEST switch, permits testing of VOR functions of the RMDI pointers, HDI VOR/LOC deviation pointer, CDI deviation bar, and TO/FROM indicators. The DME control switch is also located on the VHF NAV control panel.

The glideslope receivers have a common antenna located under the radome. Each receiver operates in conjunction with the VOR (localizer) receiver and is automatically tuned to the correct channel (co-channel) when the desired localizer frequency is selected. The glideslope information is visually presented on glideslope indicators located on the left side of the Captain's and F/O's HDI and CDI.



VHF Navigation Control Panel

NAVIGATION SYSTEM DESCRIPTION

VHF NAVIGATION SYSTEMS (cont'd.)

Operation

NAV Ground Test

Perform the test as follows:

- Tune in any localizer frequency (no signal necessary).
- Set back/front switch to FRONT.
- Set steering mode selector on HDI to V/L.
- Hold switch counterclockwise to obtain "fly up/fly left" indication on HDI and CDI. One dot upward deflection will be seen on the GS pointers, one dot left deflection on HDI VOR/LOC deviation pointers and CDI deviation bar, and all the flags will disappear.
- Hold switch clockwise to obtain "fly down/fly right" indication on HDI and CDI. One dot downward deflection will be seen on the GS pointers, one dot right deflection on HDI VOR/LOC deviation pointers and CDI deviation bar, and all the flags will disappear.

VOR Ground Test

Perform the test as follows:

- Tune in an operating VOR station.
- Place RMDI selector switch to VOR.
- Set CDI course selector to either 0° or 180°.
- Set HDI steering mode selector to V/L.
- Hold VOR test button depressed. A signal will be sent to the RMDI needle and the CDI FROM indicator to indicate 180°; additionally, the CDI course needle should center. The HDI V-bar will indicate no bank command.
- If the FROM flag does not point to 180°, it is out of phase.

NOTE: At a field where there is a VOR radiated test signal (VOT), the external test should be used if possible to provide a more thorough system check.

VHF Navigation Receivers

Always aurally identify ground station before using bearing (or displacement) indications.

NOTE: When reporting VOR station passage, report time of first complete reversal of CDI TO/FROM indication; similarly, when holding on a VOR station, use CDI TO/FROM indication to determine when to start turn onto outbound leg. When reporting VOR intersections or crossing of a VOR radial, use CDI bar and HDI V-bar (in V/L) to determine when to start turn onto outbound leg. RMDI VOR indications should not be used for these purposes because they lack the required precision; the CDI and HDI indications are normally more accurate. (The RMDI VOR needle indications are subject to the combined errors of the VHF navigation receiver system, the OBI, and the compass system.)

(cont'd.)

NAVIGATION SYSTEM DESCRIPTION

VHF NAVIGATION SYSTEMS (cont'd.)

Operation (cont'd.)

VHF Navigation Receivers (cont'd.)

At high altitude, if CDI course deviation bar is erratic, check aurally for interference.

Under certain conditions, when distant stations are being received, the CDI VOR/LOC flag may appear or "peep" even though bearing presentation appears to be normal. In such cases make the following check:

- Check TO or FROM indication on course deviation indicator.
- Rotate selected course indicator 10° off bearing and check CDI course deviation bar for approximately full scale deflection.
- Even though results of the above checks are satisfactory, bearing indications should be used with caution.

Localizer Reception

Both receivers should be tuned to the localizer facility.

If CDI VOR/LOC flag shows, do not use localizer indications for instrument approach.

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NAVIGATION SYSTEM DESCRIPTION

DISTANCE MEASURING EQUIPMENT (DME)

General Description

A DME system is installed to provide line-of-sight distance information between the aircraft and a selected ground station. The system consists of one (Captain's) interrogator, an antenna, a function switch, and two indicators.

DME ground installations are paired with specified VOR (or ILS) navigation facilities, and when the VOR frequency is selected, the associated DME channel is selected simultaneously. The system is controlled from the Captain's VHF NAV control panel on the pedestal. The system will function when the proper VOR frequency is selected, the DME function switch is in DME and warmed up, and the ground station is within line-of-sight range. The aircraft transmits coded pulse signals which trigger a transponder at the selected ground station. The transponder transmits reply pulses which are received by the airplane. The time interval between the interrogating signal sent from the airplane and the reply from ground station is measured and converted into a signal proportional to the slant range distance. This range information is displayed in nautical miles on two digital indicators. In combination with the directional information from the associated VOR facility, the distance information provides a means of determining a continuous fix of position. DME has an operational range limit of just under 200 nautical miles, depending on altitude.

While the DME system is controlled from the Captain's VHF NAV control panel, it is essentially separate from the No. 1 VHF NAV radio; only the frequency selector and volume control are common to both systems. The No. 1 VHF NAV voice toggle switch on each audio selector panel is used for DME facility aural identification. The No. 1 radio bus supplied AC and DC power to the system.

Operation

DME Interrogator

New-type interrogator searches out as follows:

- When a new station is tuned, or when lock-on is lost and distance to station is less than 50 miles, the indicator runs back to zero and searches out again.
- With TVOR or ILS tuned, the unit searches out 50 miles maximum.
- When non-DME station is tuned or DME station is out of range, the unit goes to a standby condition automatically, and,
  - If indicator shows less than 50 miles, flag drops and indicator stops.
  - If indicator shows 50 miles or more, flag drops and indicator runs to zero and stops.

Older-type interrogator searches out as follows:

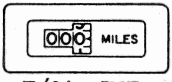
- Always searches out to 200 miles whenever a new station is selected or when lock-on is lost.
- Searches continually (unless in STBY position) regardless of station tuned or range of station.

NAVIGATION SYSTEM DESCRIPTION

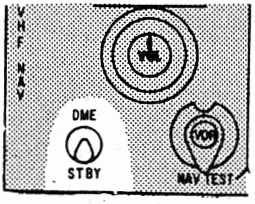
DISTANCE MEASURING EQUIPMENT (DME) (cont'd.)

Controls & Indicators

CAPTAIN'S DME INDICATOR



F/O's DME INDICATOR



DME FUNCTION SWITCH

DME Function Switch

The DME/STBY toggle switch on the Captain's VHF NAV control panel controls DME operation. In the STBY position, power is supplied to the DME components to allow immediate operation when desired. In the DME position, if the proper VOR frequency is selected on the Captain's VHF NAV receiver, the distance information from the ground station will be displayed when within range. When distance information is not desired, the function switch should be returned to the STBY position. The function switch on the F/O's VHF NAV control panel is inoperative.

Indicators

One digital (counter-type) mileage indicator is installed in the upper right corner of the Captain's CDI; the F/O's separate indicator is located under his/her CDI. The counter dials are covered by a shutter on the Captain's CDI and a red bar on the F/O's indicator whenever a correct distance to a station is not being computed (DME signal loss, improper VOR frequency selected, function switch in STBY, DC power loss, etc.). When the VOR frequency is initially selected and the function switch placed to DME, the shutter and red bar will drop away when the station distance is being computed (up to 15 or 20 seconds may be needed to search for correct signal). The distance shown on the counters will then increase or decrease depending on direction of flight in relation to the ground station. In the event of a DC power failure, the shutter and bar will cover the counter dials and the counters will spin. If only AC power is lost, the shutter and bar will not cover the counters, but the counters will stop driving. If either power source is lost, there will be no aural DME identification signal.

NAVIGATION SYSTEM DESCRIPTION

AUTOMATIC DIRECTION FINDER SYSTEM

General Description

The airplane is equipped with an ADF system consisting of a receiver, sense antenna, loop antenna, radio magnetic indicator, and a remote control panel. The receiver is completely transistorized and requires only DC power. The receiver covers a frequency range of 190 to 1750 kc. The sense antenna is located on the bottom right of the fuselage just aft of the wing leading edge. A fixed loop antenna is mounted on top of the fuselage a few feet forward of the wing leading edge. The fixed loop antenna has no moving parts, instead it uses two pairs of loops; one pair is orientated parallel to the fore and aft axis of the airplane, the other pair is oriented perpendicular to the first pair. Signals are received through each pair of loops and sent to the receiver in the radio rack where the loop signals are reproduced on another set of loops. A resolver combines the input of loop signals and determines the direction of the station. (The loop control switch on the ADF control panel does not physically rotate the loop antennas; it electrically repositions the loop circuitry.) The signal is then fed through a synchro to drive the RMDI needles.

The ADF control panel is located on the pedestal. The panel contains a function selector switch (with concentric gain control knob), a frequency selector band switch and tuning knob, a beat frequency oscillator control switch, a tuning meter, a frequency indicator window, and a loop switch.

Operation

Always aurally identify ground station before using aural signals or bearing indications.

Conventional tuning procedures (monitoring aural signal, RMDI needles, etc.) should produce satisfactory reception for most flight ADF usage requirements, particularly in terminal areas where ADF facilities to be used are not too distant at time of need. Also, time may not permit using a lengthy tuning procedure in these areas. However, the following procedure should produce the best (and maximum range) reception with this equipment. To the extent time permits under existing flight conditions, this procedure should be followed whenever difficulty in obtaining satisfactory reception is experienced.

- Function Selector - ANT.

- BFO Switch - ON.

- Tune to zero beat (audio null). Do not use tuning meter.

- BFO Switch - OFF.

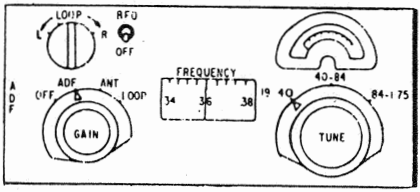
NOTE: Because of the extreme sensitivity of this receiver, the station should again be aurally identified at this point.

Supplied by Jeppesen Sanderson

NAVIGATION SYSTEM DESCRIPTION

AUTOMATIC DIRECTION FINDER SYSTEM (cont'd.)

Controls & Indicators



ADF Control Panel

Frequency Selector Band Switch and Tuning Knob

Selection of a frequency is accomplished by operating the frequency selector band switch and a concentric tuning control knob. As the tuning knob is rotated, in any selected band, the frequency appears on the indicator dial.

Function Selector Switch

A four-position (OFF/ADF/ANT/LOOP) function selector switch, located on the ADF control panel, permits selection of the following functions:

- OFF -- Permits turning off the ADF. However, during flight, the selector should be left in one of the operating positions.

- ADF -- Provides automatic visual bearing indication and, if signals are voice or tone modulated, aural reception. Each receiver utilizes a directional fixed-loop antenna (to sense direction of the signal) and a non-directional sense antenna (to resolve the 180° ambiguity of the loop antenna). The visual bearing indication is presented on the RMDI on each flight instrument panel. The double-bar pointer indicates bearings produced by the ADF receiver. It should be remembered that the receiver cannot automatically discriminate between multiple signals received, but may indicate a visual bearing that is the vectorial sum of desired and interfering signals. The ADF position should not be used for aural radio range work since automatic volume control is provided in this position.

- ANT -- Provides aural reception only of voice or tone modulating signals, using the non-directional sense antenna. This position normally should be used during standard range approach (or any aural utilization or range stations). When precipitation static exists, aural reception can be improved by using the LOOP position.

(cont'd.)

NAVIGATION SYSTEM DESCRIPTION

AUTOMATIC DIRECTION FINDER SYSTEM (cont'd.)

Controls & Indicators (cont'd.)

Function Selector Switch (cont'd.)

- LOOP - Provides aural reception of voice or tone modulated signals using only the loop antenna. Visual bearing indications can be obtained by using the loop rotator to rotate the loop circuitry to the signal's aural-null position. Bearings obtained in this manner are subject to 180° ambiguity which can only be resolved by standard methods of orientation. Aural radio range signals, received over loop antenna only, must be used with caution. Generally, such signals are accurate only when flying straight with wings level, and in smooth air.

Tuning Meter

A meter on the control panel provides a relative indication of received signal strength.

Beat Frequency Oscillator (BFO) Control Switch

Aural determination of bearings are made more easily by using the BFO. It is controlled by an ON/OFF toggle switch and produces a tone enabling accurate determination of the true null.

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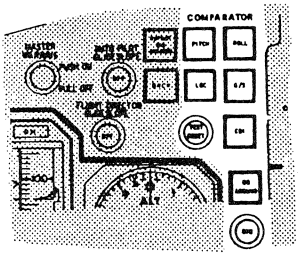
NAVIGATION SYSTEM DESCRIPTION

COMPARATOR WARNING MONITOR SYSTEM

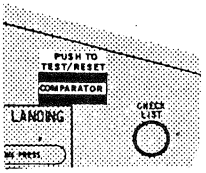
General Description

A Comparator Warning Monitor System is installed on the forward instrument panels. The system supplements conventional flag warnings in the respective individual instruments; it will detect some faults which cannot be detected by the warning flags. This is accomplished by comparing duplicate flight instruments and giving a light warning (a specific instrument warning light and a master comparator warning light) when the instruments differ more than a set amount. The fundamental design concept of the comparator system rests on the high degree of improbability of two instrument systems indicating incorrectly at the same time, in the same direction, and by the same amount.

The indicating systems monitored are: attitude (pitch and roll), CDI compass cards, localizer, and glideslope.



Captain's Instrument Panel



F/O's Instrument Panel

Subsystem Monitoring

Subsystem monitoring is accomplished as follows:

Glideslope and Localizer - The output signals from the two receivers are compared, provided both receivers are receiving usable glideslope or localizer signals. Actual indications are not compared; therefore, no warning is provided for faults in the wiring to the indicator or for malfunctions within the indicators, e.g., for a stuck needle. Monitoring is not provided on VOR's.

NOTE: Glideslope and localizer monitoring functions become armed after the ILS frequency is selected on both receivers. NAV flags will not automatically trigger comparator warning.

CDI Compass Cards - The position of the compass cards in the indicators are compared; thus, warning is provided for almost all cases of erroneous indications, except when both are in error but read the same. Warning tolerances vary as a function of bank and pitch angle.

HDI Pitch and Roll - The positions of the attitude tapes and the position of the horizon bars are compared. The scope of fault monitoring provided is essentially the same as for the CDI compass cards.

NAVIGATION SYSTEM DESCRIPTION

COMPARATOR WARNING MONITOR SYSTEM (cont'd.)

Comparator Lights

The subsystem lights operate independently of each other. The master comparator light (on the F/O's panel) illuminates any time one of the subsystem lights illuminate. For example, if the system detects an out-of-tolerance difference between the two HDI bars, the roll light and the master comparator light will illuminate. Faults detected in any of the other four dual systems monitored (PITCH, CDI, LOC, G/S) will provide similar warning.

The master comparator light alone will illuminate any time power is lost to the comparator system.

If the master comparator light is illuminated and another subsystem fault is detected, the light will extinguish and illuminate again.

Depressing the master comparator light lens will extinguish the master comparator light only, and will rearm the master comparator light circuit.

Depressing the test/reset button illuminates all five specific subsystem lights (ROLL, PITCH, LOC, G/S and CDI) and the master comparator light. Lights extinguish when released, except an uncleared fault subsystem light.

Depressing the dim button light dims all five subsystem lights. It has no effect on the master comparator light.

Operation

NOTE: System is supplementary; individual instruments must be monitored also.

Comparator System Test

Test/Reset Button - DEPRESS. All system lights should illuminate and extinguish.

Comparator Lights/Switches Function:

- A comparator detected fault (e.g., CDI) will illuminate the master comparator light and the respective subsystem light(s). Additionally, the master comparator light alone will illuminate any time power is lost to the comparator system.

- The master comparator light can be extinguished by depresssing it, unless power is lost to the comparator system. The subsystem lights can be extinguished, only after the fault that caused the light(s) to illuminate is cleared, by depressing the test/reset button.

- If the master comparator light and a subsystem light are illuminated, the illumination of another subsystem light will cause the comparator light to extinguish and illuminate again.

- If the master comparator light is extinguished while a subsystem light is illuminated, the subsequent illumination of another subsystem light will cause the master comparator light to illuminate again.

- If the master comparator light has been extinguished when a fault is not cleared, the master comparator light will illuminate again when the test/reset button is depressed.

(cont'd.)

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NAVIGATION SYSTEM DESCRIPTION

COMPARATOR WARNING MONITOR SYSTEM (cont'd.)

Operation (cont'd.)

Comparator System Test (cont'd.)

NOTE: After a comparator warning, a check of individual instruments must be made to locate fault.

The following table shows how much difference must exist between monitored sybsystems (and for how long) before comparator lights illuminate.

SUBSYSTEM	INDICATOR DIFFERENCE	TIME DELAY
Pitch	5 ± 1°	2 seconds
Roll	5 ± 1°	2 seconds
CDI	8 ± 2° plus a function (20% of the combined pitch angle and bank angle.*	4 seconds
LOC (Localizer)	1/2 to 3/4 dot when airplane is at center of beam, increasing to about 1 dot when airplane is at edge of beam.	2 seconds
GS (Glideslope)	1/2 to 3/4 dot when airplane is at center of beam, increasing to about 1 dot when airplane is at edge of beam.	4 seconds

*Example: With a 10° pitch angle and a 20° bank angle, the comparator warning tolerance for the CDI heading is about 12° to 16° (8 ± 2° plus 20% of 30°, or 8 ± 2° plus 6°).

Resetting System Following a Comparator Detected Fault

Master Comparator Light - DEPRESS. Extinguishes master comparator light.

Subsystem Light - FIX FAULT. If fault is cleared.

Test/Reset Button - DEPRESS. Extinguishes subsystem light; if fault is not cleared, depressing test/reset button will not extinguish subsystem light but will re-illuminate master comparator light.

Supplied by Jeppesen Sanderson

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NAVIGATION SYSTEM DESCRIPTION

MARKER BEACON SYSTEM

The marker beacon receiver is used to provide aural and visual signals whenever the airplane passes over a 75 MC marker transmitter. These marker transmitters are usually associated with airways, station location Z markers, and approach markers of the instrument landing systems. The marker receiver also provides an ILS middle marker signal to the autopilot during coupled approaches and to the flight director system.

A HI/LO marker beacon switch is located on the pedestal just forward of the SELCAL panel. This switch allows the pilots to increase (HI) or decrease (LO) the sensitivity of the marker beacon receiver. This in turn will lengthen or shorten the signal duration.

Three marker beacon lights (white, amber, and blue) are installed on the Captain's and F/O's instrument panels. Airways and approach markers are identified by their intermittent flashes and enable the pilot to identify the marker over which s/he is flying. Cone-of-silence markers transmit a steady signal. The white light indicates passage over an airway or cone-of-silence marker, the blue light an outermarker, and the amber light a middle marker. These lights are automatically in operation whenever the marker beacon receiver is receiving power.

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NAVIGATION SYSTEM DESCRIPTION

ATC TRANSPONDER

General Description

The ATC transponder is a combination receiver/transmitter unit used for identification of the aircraft on ground radar screens. Interrogating signals received from the ground radar by the unit result in automatically transmitted pulses which reinforce the reflected return signal from the ground radar. Upon request from the ground controller, a special identification can be transmitted which consists of a single additional pulse located outside the normal pulse train. The interrogation frequency is 1030 MC and the reply frequency 1090 MC. The range of the transmitter follows line-of-sight characteristics, about 200 nautical miles at 30,000 feet. The control panel for the set is located on the pedestal.

AC and DC power for transponder operation is supplied by the No. 1 radio bus. The antenna is mounted on the bottom of the fuselage, just forward of the No. 1 VHF communications antenna.

Operation

Initial Settings

- Transponder Selector - STBY.
- Mode Selector - A.
- Reply Code Selector - SELECT DESIRED CODE.
- Transfer Switch - 1.

NOTE: Only one transponder unit is installed; however, either position 1 or 2 of the TFR switch will permit its operation. For purposes of standarization, it is recommended that position 1 be used.

- Altitude Reporting Switch - ALT RPTG.

Inflight Operation

When transponder is initially turned from OFF to STBY, unit requires a warm-up time of 80 seconds before use. Leave selector in STBY, unless needed, as it will then be ready for immediate use.

Place selector to ON for normal operation or to LO SENS when specifically requested to do so by ATC.

Depress IDENT button when specifically requested to do so by ATC. Momentarily depressing button starts a strong IDENT reply pulse which lasts 10 to 15 seconds, and produces a bright return on the Controller's scope for one or two sweeps.

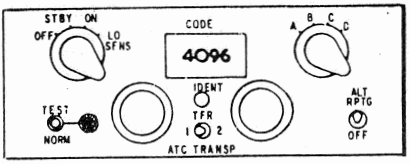
Leave ALT RPTG switch on unless other instructions are received from ATC.

NOTE: A code OFF flag will appear in the Captain's altimeter if the altimeter fails to provide encoded altitude information.

NAVIGATION SYSTEM DESCRIPTION

ATC TRANSPONDER (cont'd.)

Controls & Indicators



ATC Transponder Selector

The selector is marked OFF, STBY, ON, and LO SENS. The transponder can be turned to STBY and left, and at any time after about 80 seconds can be turned to ON or LO SENS with immediate operation; or the transponder can be turned to ON or LO SENS immediately and about 80 seconds later will become operative. When the transponder is used periodically during flight, switch from STBY to ON as required. Place the selector in LO SENS (low sensitivity) only when requested by radar ground control.

Reply Code Selectors

Two sets of knobs, each consisting of two concentric knobs, are used to set up the code to be transmitted. The code number will appear in the window just above the knobs. The unit is capable of transmitting codes from "0000" to "7777"; however, a total of only 4096 separate codes are available due to the absence of numerals 8 and 9 from the code selector.

Ident Switch

This pushbutton-type switch placarded IDENT, causes a special reply signal to be produced which results in a bright display on the ground radar. The switch should be depressed when additional identification is requested by the ground controller. This additional signal will remain illuminated for 10 - 15 seconds after the button is released.

Mode Selector

This selector switch is used to select modes A, B, C, or D. Leave this selector on Mode A at all times.

Transponder Transfer Switch

This switch, with 1 and 2 positions, provides for selecting one of two transponder units. However, at the present time, only one transponder is installed. Leave this TFR selector in position 1.

Altitude Reporting Switch

On airplanes with altitude reporting capability, the ALT RPTG position of this switch permits the transponder to automatically transmit altitude information when interrogated by ATC. For standardization on those airplanes without altitude reporting capability, this switch should be left in ALT RPTG position.

(cont'd.)

NAVIGATION SYSTEM DESCRIPTION

ATC TRANSPONDER (cont'd.)

Controls & Indicators (cont'd.)

Test Switch

This switch, labeled TEST/NORM, when placed to the TEST position, causes the transponder to transmit a reply signal. Proper operation of the transmitter is indicated by the illumination of the adjacent transmitter indicator.

Transponder Indicator

This green light, adjacent to the test switch, will illuminate whenever the transponder is transmitting a normal reply signal and the test switch is in the TEST or NORMAL position.

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NAVIGATION SYSTEM DESCRIPTION

WEATHER RADAR

General Description

This airplane is equipped with a Bendix RDR-1E X-band radar system. The primary purpose of this radar is to permit interpretation of weather conditions and selection of a route that will avoid the areas of greatest turbulence. While there are two types of turbulence, clear air turbulence and turbulence associated with storm cells or precipitation, it is with the latter type that radar is helpful. This radar may be used also for mapping of prominent terrain features (mountains, large bodies of water, etc.).

The radar system consists of a rotating antenna assembly in the nose of the airplane, a single receiver-transmitter unit in compartment just aft of the radome, and the necessary indicator and controls in the cockpit. The radar antenna is stabilized throughout its 360° rotation so as to minimize displacement of the radar beam with changes in airplane attitude. Signals for antenna stabilization are provided by the Captain's No. 1 vertical gyro. No provision is made to cut out radar stabilization.

Electrical power for the radar system is supplied by the No. 1 AC bus and the main DC bus.

Basic Operating Principles

Very short wave length (3.2 CM) radio energy is emitted by the transmitter and associated rotating antenna/reflector assembly in the nose of the airplane. A portion of the radiated energy that strikes any matter (precipitation and other solid matter) having reflective characteristics is returned and picked up by the reflector; the radar receiver converts these reflected impulses into visible indications displayed on the indicator (scope), which is the face of a cathode ray tube.

Patterns are produced by the momentary brightening of a luminous rotating sweep line on the scope which rotates in synchronization with the rotation of the antenna. The sweep line will brighten at a point along its length that is directly proportional to the distance between the airplane and the target reflecting the signal. The direction the antenna is pointing at the instant the pulse of energy is radiated determines the position, in azimuth, of the echo on the scope display. The range, in nautical miles, is determined by reference to the calibrated range marks on the face of the scope.

Beam Emission

The antenna/reflector assembly concentrates most of the emitted energy into a 3.6° beam. In order to scan the surrounding area, the antenna is continuously rotated (similar to a rotating searchlight) in a clockwise direction about its vertical axis at 15 RPM. Since the antenna is located on the nose of the airplane, the emission will be blocked out for about 120° of rotation while the reflector is sweeping the area to the rear which intersects the airplane structure (wings and fuselage).

The plane-of-rotation of the beam can be adjusted (tilted) from horizontal to about 10° above or 15° below horizontal. When the beam is tilted downward, its plane-of-rotation describes a cone, the antenna being the apex of the cone.

Supplied by Jeppesen Sanderson

NAVIGATION SYSTEM DESCRIPTION

WEATHER RADAR (cont'd.)

Sensitivity Time Control

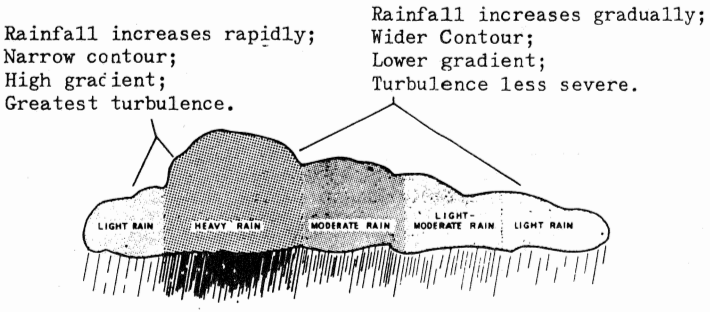
The sensitivity time control (STC) is an automatic feature which reduces receiver gain on short range targets where echoes are strong. With STC, receiver gain is minimum at zero range and gradually increases up to approximately 30 miles, beyond which gain is normal as established by the setting of the gain knob on the control panel. This prevents saturation of the receiver with strong short-range signal returns, which would cause a loss of receiver sensitivity and fading of targets on the scope, and insures that close-in targets and distant targets of the same physical size will have equal scope display.

Weather Mapping and Storm Detection

The primary purpose of weather surveillance radar is to enable the pilot to interpret weather conditions and to select a route that will avoid the areas of greatest turbulence associated with storm cells or precipitation. All forms of precipitation (rain, snow, hail), as well as very dense clouds, reflect a portion of the radar beam and thus produce a display on the radar scope. The intensity of the reflected signals will vary with the concentration of the moisture reflecting the beam.

The greatest turbulence associated with precipitation is usually found when entering or leaving the core of a storm cell. Avoiding this core will usually result in the avoidance of severe turbulence.

However, precipitation in itself has only limited significance in producing turbulence; it is the rate at which precipitation increases or decreases with horizontal distance that is significant. This rate is known as precipitation gradient. The gradient is highest and turbulence is greatest when precipitation increases or decreases rapidly over a short distance. Thus, a radar scope presentation of the precipitation gradient will give a direct indication of the relative severity of turbulence. This is shown graphically in the following sketch.



(cont'd.)

NAVIGATION SYSTEM DESCRIPTION

WEATHER RADAR (cont'd.)

Weather Mapping and Storm Detection (cont'd.)

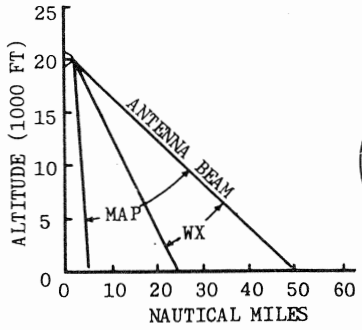
In order to identify the location of the areas of highest precipitation gradient, the system incorporates a feature known as iso-echo contour which operates as follows: In some cases, when scanning a wide-spread area in which there is precipitation, a large part of the scope will show a return because of the presence of radar-reflecting particles throughout the area. Although the intensity of the reflected signals will vary with the concentration of the moisture reflecting the beam, the scope display may appear to be almost uniform in intensity across wide areas due to the inability of the scope phosphorescent coating to distinguish more than a limited range of light intensities. When the radar is operating with contour on, all signals above a given level, such as heavy precipitation echoes, are erased leaving a black area on the scope. The precipitation rate is greatest in these blacked-out centers. Since the surrounding moderate precipitation areas remain white, the black (erased) heavy precipitation area defines the contour of the storm cell.

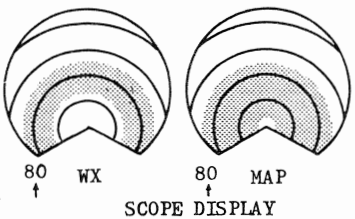
CONTOUR OFF

CONTOUR ON

Ground Mapping

The use of the system for ground mapping prominent terrain features (mountains, cities, large bodies of water, etc.) is essentially the same as for weather mapping, except the antenna is tilted downward to pick up terrain features. The actual area covered by the antenna will be determined by the altitude of the airplane, the degree of antenna tilt, and the radar mode selected (WX or MAP). With a given antenna tilt, the higher the airplane, the further the area scanned will be; also with a given altitude, the greater the antenna downward tilt, the closer the area scanned will be. If the WX mode is used for ground mapping, the ground is being painted by a "pencil" beam and the returns will paint a fairly narrow band on the scope. For example, at 20,000 feet with about 6° of downward tilt, the beam will scan an area from about 25 miles out to about 50 miles out. However, if the MAP mode is used, it has the effect of depressing the lower portion of the beam so as to scan close-in terrain targets. Thus, using the same example given above, the beam will scan from about 5 miles out to about 50 miles out. This is shown in the following diagram.





SCOPE DISPLAY
(80 MILE RANGE, 20 MILE RANGE MARKS)

(cont'd.)

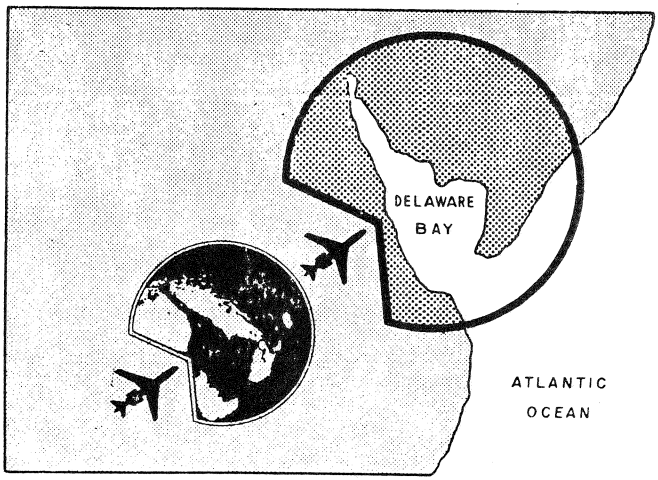
NAVIGATION SYSTEM DESCRIPTION

WEATHER RADAR (cont'd.)

Ground Mapping (cont'd.)

The position of identified terrain features relative to the position of the airplane can be determined by reference to the scope range marks and azimuth calibration. Bear in mind, however, that all ranges in ground mapping are slant ranges. Therefore, all distances are from the nose of the airplane to the ground feature or object being observed on the scope.

NOTE: For familiarization with the scope display of ground features, it is suggested that the system be operated in this mode during VFR conditions, whenever flight conditions permit.



Typical scope display of ground mapped area having sharp water-to-land discontinuity.

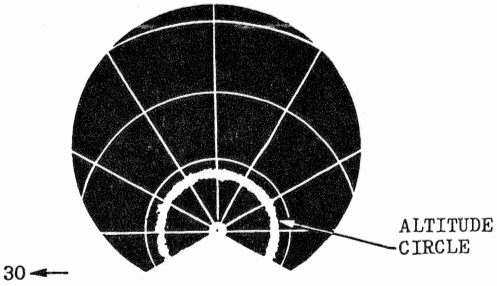
Here the airplane is flying northeasterly approaching Delaware Bay. The dark area on the scope reproduces the outline of the Bay.

NAVIGATION SYSTEM DESCRIPTION

WEATHER RADAR (cont'd.)

Altitude Circle

Through its ground mapping capability the system has limited value as an indicator for the avoidance of high terrain. The method of using the system for this purpose is known as the safety circle (or altitude circle) technique. The safety circle appears as a fuzzy or rough circle, similar to a range mark. It is caused by a small amount of the radiated energy from the antenna leaking down to the ground and being reflected as a target. The range of this circle roughly indicates the aircraft altitude above the terrain.



Essentially the system consists of lowering the antenna to pick up ground returns and then flying the airplane so that the portion of the scope within the 10-mile range mark remains clear of ground return.

CAUTION: The use of radar for terrain avoidance should be considered only as an additional safety feature supplementing standard procedures and techniques of terrain avoidance.

NAVIGATION SYSTEM DESCRIPTION

WEATHER RADAR (cont'd.)

Operation

General Notes

Use Radar Judiciously - The radar equipment should be used judiciously so that optimum benefit may be obtained without sacrificing any ability to maintain a maximum traffic watch when not definitely in clouds. Alertness to other traffic is, of course, the prime consideration.

To attain this objective, normally only one pilot will observe radar at any one time. Recognizing that there are situations where it may be advantageous for both pilots to simultaneously observe radar scope indications, this is permissible in special cases at the Captain's discretion.

Collision Warning - Although under some conditions other aircraft may be detected, this type radar cannot be used as a reliable collision warning indicator for the avoidance of other aircraft.

Takeoff Use of Radar - Do not operate radar other than in STBY during takeoff. If it may be required shortly after takeoff, turn on to STBY when taxiing away from ramp so that it will be warmed up and ready for immediate use after becoming airborne.

Enroute Use of Radar - Normally, the radar should be turned on only when it is needed, due to the rather short operating life of certain components. However, it should not be turned on and off frequently during flight when intermittent operation is desired as frequent on-off cycling will also shorten the life of tubes and other components. Therefore, leave function selector in STBY during intervals when the radar is not to be used for surveillance.

Landing Use of Radar - Turn radar system off at end of landing roll (if not turned off prior to landing).

Thunderstorm Avoidance - Detour all thunderstorm echoes VFR is possible.

Initial Adjustment

The self-test feature of this radar permits making initial adjustments at any time without radiating radar energy; the transmitter is disabled with the function selector in TEST. The following procedure assumes that this self-test feature is used for initial adjustment.

1. Preset controls as follows:

   - Erase Rate - FULL CLOCKWISE
   - Trace Adjust - FULL COUNTERCLOCKWISE
   - Range & Marks - 180/30
   - Gain - FIXED (FULL CLOCKWISE)
   - Tilt - 10° UP.
   - Function Selector - TEST.

2. After warm-up, rotate trace adjust clockwise to get pattern similar to that shown on the following page. Test noise band should appear coarse-grained but should not bloom; system noise will be relatively little at this time.

   NOTE: If trace adjust is set to display large amount of system noise, as is frequently done with other indicators, video presentation will bloom excessively.

(cont'd.)

NAVIGATION SYSTEM DESCRIPTION

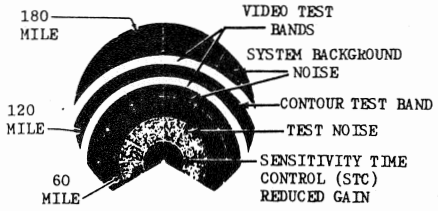
WEATHER RADAR (cont'd.)

Operation (cont'd.)

Initial Adjustment (cont'd.)

3. Rotate erase rate counterclockwise until test pattern just fades prior to being rewritten. No further adjustment of erase rate should be necessary.

4. Recheck test noise band; a slight readjustment of trace adjust may be required to get display called for in step 2. No further adjustment of trace adjust should be necessary.



NOTE: Test pattern may not appear exactly as shown here (for example, video test bands may be a little narrower), but it should have same general characteristics.

Manipulation of Controls

Function Selector - Should be positioned as follows:

- OFF if radar use not required.

- STBY when use of radar may be required at any moment.

  NOTE: On some units, a 20-second time delay will occur when switching from STBY to any operating position.

- WX NORMAL for weather detection or for mapping far-out terrain targets.

- WX CONTOUR for evaluation of close-in weather targets. Remember that this position eliminates the heavy return from the scope; therefore, the selector should not be left in this position for extended periods.

- MAP for extended surveillance of close-in terrain targets.

- TEST for initial adjustment.

(cont'd.)

NAVIGATION SYSTEM DESCRIPTION

WEATHER RADAR (cont'd.)

Operation (cont'd.)

Manipulation of Controls (cont'd.)

Range & Marks Selector - Select as follows:

- 180/30 for scanning well ahead for the selection of a suitable route of flight; provides maximum range detection of weather or terrain targets.

- 80/20 for most effective use of radar at high speed for avoiding areas of greatest turbulence.

- 30/10 for use in low altitude, low speed work when approaching terminal areas; provides maximum scale expansion and resolution of targets within this range.

Antenna Tilt Control - Set for desired area of surveillance, airplane altitude, and minimum ground clutter. At cruising altitude: 2° to 5° down-tilt for maximum range weather detection; 3° to 6° down-tilt for maximum terrain range. When scanning for distant weather targets at airplane altitude in the 180/30 range at cruising altitude, it is necessary (due to curvature of the earth) to use down-tilt. For example, at 20,000 feet altitude, if 0° tilt is used, the beam will scan at approximately 30,000 feet, beyond 100 miles from the airplane.

Gain Control - Normally, FIXED position should provide proper gain setting; however, Maintenance adjustment to the radar black box to establish proper fixed gain level is a delicate one, and normal aging of circuits may cause some drift in fixed gain. With proper fixed gain set in, the scope should not show too much light precipitation since this makes it difficult to identify individual cells, in fact it makes it almost impossible unless the precipitation intensity in the cell is heavy enough for contour to show a hole.

If too much light precipitation is showing in an area of widespread precipitation, some reduction in gain may help to better define the areas of heavy precipitation. Gain level should not be reduced simply to eliminate or reduce ground clutter.

Trace Adjust - Normally the setting established under initial adjustment will give the optimum trace adjust level. However, as ranges are reselected the trace adjust may need to be slightly reset. Set trace adjust to point where system noise (not test noise) first appears, then back off until it disappears. Avoid the common tendency of setting trace adjust too high since this will cause excessive blooming of scope display.

Erase Rate - Normally the setting established under initial adjustment will give the optimum erase rate level. As with trace adjust, avoid too slow an erase rate since this produces blooming of scope display which causes returns to show up as large blobs on the scope. On the other hand, don't set erase rate too fast, as this can cause returns to appear to wash out on the left side of the scope while returns are still being displayed on the right side of the scope. This will give the impression that the picture is hanging on the right side of the scope.

NAVIGATION SYSTEM DESCRIPTION

WEATHER RADAR (cont'd.)

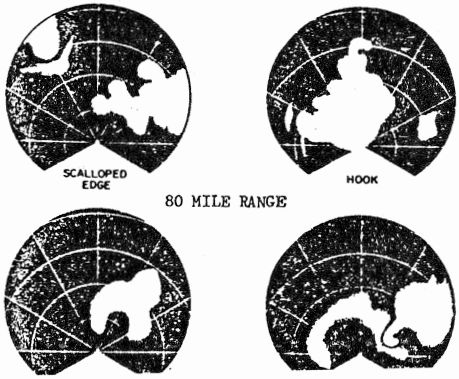
Operation (cont'd.)

Interpretation of Radar Scope Display

The radar is used to detect symptoms of turbulence, since turbulence cannot be directly indicated. The density and density gradient of precipitation are the foremost criterion for turbulence determination. X-band displays more detailed precipitation returns than the more familiar C-band. Since X-band radar energy is reflected more readily at its shorter wavelength, it requires a slightly different interpretation of returns. More distanct returns are shown by X-band, and many areas of light precipitation that C-band penetrates are displayed on the scope.

Scope returns which indicate a higher degree of turbulence are:

- Weather returns displayed beyond 75-mile range.
- Steep density gradients of precipitation as observed by thin bright bands surrounding contour holes in a weather return.
- Echoes which are rapidly changing in either size, shape, or intensity.
- Echoes which have certain patters such as scalloped edged or U-shaped, or have distinctive features such as hooks or fingers as illustrated below.



The use of radar at high enroute altitudes requires certain factors to be considered:

- Scope returns will normally appear only if moisture or precipitation is present. When a cloud build-up can be seen visually but not on the scope, the tilt control should be manipulated to vertically scan the build-up so that any moisture or precipitation present will be deplayed on the scope.

(cont'd.)

NAVIGATION SYSTEM DESCRIPTION

WEATHER RADAR (cont'd.)

Operation (cont'd.)

Interpretation of Radar Scope Display (cont'd.)

- Precipitation will sometimes only occur at lower altitudes, but associated turbulence may be present at altitudes above the precipitation return. Down-tilt of 2°-5° is normally used to detect the denser portions of storms.

- During long range scanning, storm patterns at lower altitudes may disappear because they are scanned over at shorter ranges. Down-tilt and shorter range, together with contour, may re-establish the returns, if continued monitoring is desired.

- X-band permits effective terrain mapping, and with a greater than normal down-tilt weather returns will merge with mapping returns. Contour rings will merge with the terrain echoes, and strong terrain echoes will also show contour holes. Normally, tilt should be adjusted so that only a few isolated ground returns are visible, to avoid misinterpreting ground returns.

Notes on Radar Interpretation

- X-band may paint light recipitation out to about 30 miles range, even though it was previously undetected at longer ranges. These echoes are of low density and turbulence will be insignificant.

- Scope interference or jamming may possibly be overcome by the use of contour.

- If radar is to be used on climb-out, stabilization error or overscanning may require greater tilt manipulation to get an effective display.

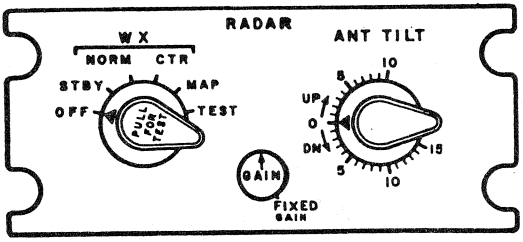
- Thunderstorm echoes tend to increase in size as they are approached and less intense echoes begin to show, effectively narrowing the corridors previously shown between strong echoes.

- The horizontal and vertical magnitude of storm cells can be determined by manipulation of the tilt control. On zero-tilt, the beam intersects the storm at the level of the airplane. On up-tilt, the beam intersects the upper portion of the storm, which is usually smaller in diameter. On down-tilt, the beam intersects the lower portion of the storm which is usually large in diameter. When scanning an area of activity, an advantage of using some up-tilt is that it will usually outline the core of storm cells better by eliminating much of the light rain clutter in the lower levels.

NAVIGATION SYSTEM DESCRIPTION

WEATHER RADAR (cont'd.)

Controls & Indicators



Radar Control Panel

This panel is located on the forward electronics control panel in the cockpit. The function selector, gain control, and antenna tilt control are located on the panel.

Function Selector

This selector, with OFF/STBY/NORM/CTR/MAP/TEST positions, is used to select the mode of radar operation as follows:

OFF -- All power is removed from the radar system and the system is completely deactivated.

STBY - Power is applied to certain circuits in the radar set to warm up the set before high voltages are applied. In the event this position is bypassed when turning the set ON, a 3-minute time delay occurs before high voltage is applied to the set.

NORM - The radar system is activated and complete echoes, that is, all returned signals, are displayed on the radar scope.

CTR -- All returns above a given level, such as heavy precipitation echoes, are erased leaving a black area in the heavy return images on the scope. Since the surrounding moderate precipitation areas remain white, the black (erased) areas define the contour of the storm cells.

MAP -- Used for mapping of prominent terrain features. When the radar is operated in this mode, the beam width is increased from the normal 3° to about 28°. This is done by depressing only the lower part of the beam so that terrain coverage is increased (the radar set sees more terrain) and a better terrain picture is displayed on the scope.

(cont'd.)

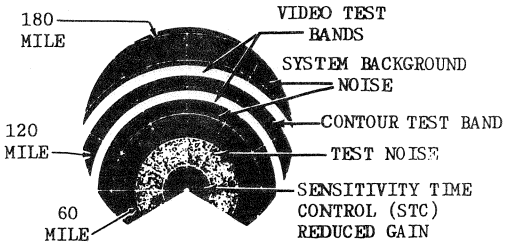
NAVIGATION SYSTEM DESCRIPTION

WEATHER RADAR (cont'd.)

Controls & Indicators (cont'd.)

Function Selector (cont'd.)

TEST - The function selector knob must be pulled to rotate it into this position. In this position, the test pattern shown below should be displayed on the scope, indicating normal radar operation. (The range selector must be in the 180/30 position to obtain the proper test pattern.)



NOTE: Test pattern may not appear exactly as shown here (for example, video test bands may be a little narrower), but it should have same general characteristics.

Gain Control

In the full clockwise (detented) position, the radar system provides automatic gain control and will normally provide optimum sensitivity of the radar receiver. However, if desired, the knob can be rotated to alter radar gain to suit individual preference. Rotating the knob counterclockwise reduces gain.

Ant Tilt Control

This control permits tilting the antenna over a range of 25°, from 10° up from the airplane centerline to 15° down.

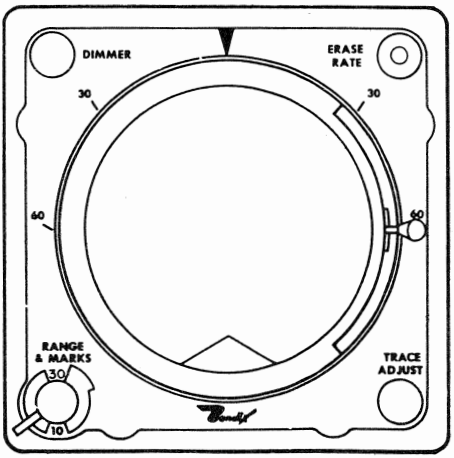
NAVIGATION SYSTEM DESCRIPTION

WEATHER RADAR (cont'd.)

Controls & Indicators (cont'd.)

Radar Scope and Controls

The radar scope, located on the forward electronics panel, is of the daylight type, i.e., a greater amount of light is emitted from the tube to improve daylight viewing. The following controls are located on the scope.



- Range & Marks Control - This control is used to select the range of the indicator display in nautical miles. Two numbers will appear in each selected position; the upper number is the maximum range and the lower number is the distance between range marks. Selectable positions are 180/30, 80/20, and 30/10.

- Dimmer Control - This control sets the intensity of the placard lighting on the scope control panel.

- Erase Rate Control - This control determines the length of time the target will be displayed on the scope. At full counterclockwise rotation of the control, the erase rate is slowest, about 3 sweeps of the trace line occur before the original picture is erased. Clockwise rotation will increase the erase rate and targets will disappear from the scope more quickly.

- Trace Adjust Control - This control sets the brightness of the sweep line.

- Filter Adjust Lever - This lever, located on the right of the scope, rotates a Polaroid filter over the scope face to permit compensating for changes in cockpit lighting level.

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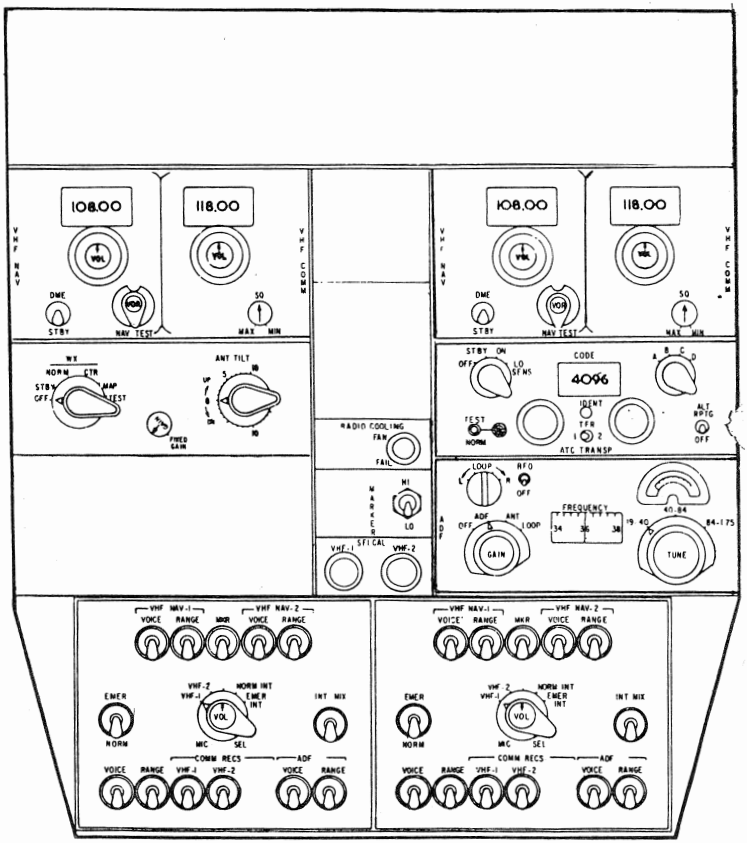
COMMUNICATIONS SYSTEM DESCRIPTION

LOCATIONS



Pedestal Electronics Control Panel

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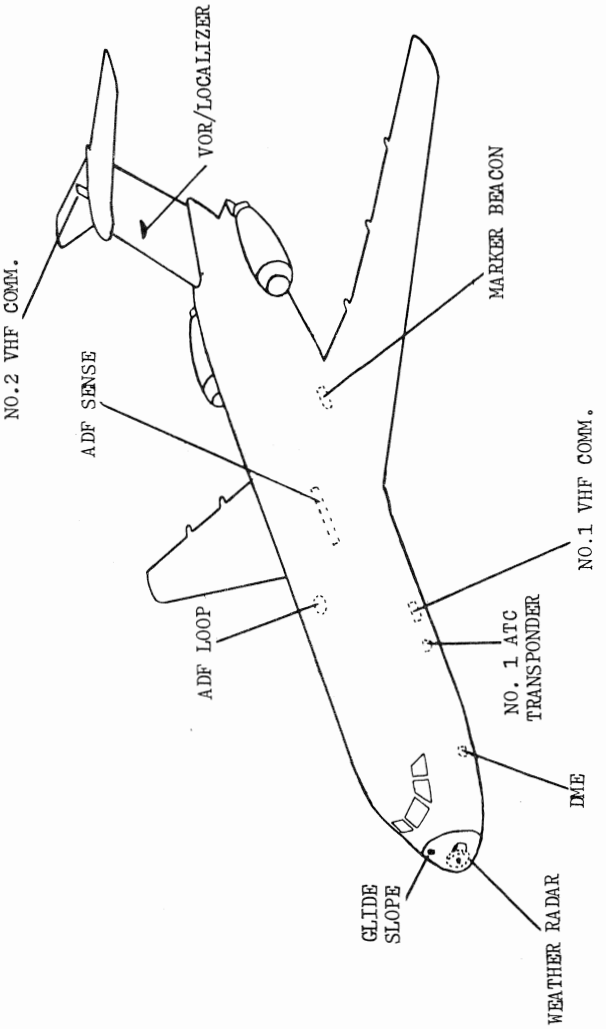
COMMUNICATIONS SYSTEM DESCRIPTION

ANTENNA IDENTIFICATION & LOCATIONS



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COMMUNICATIONS SYSTEM DESCRIPTION

RADIO POWER SYSTEM

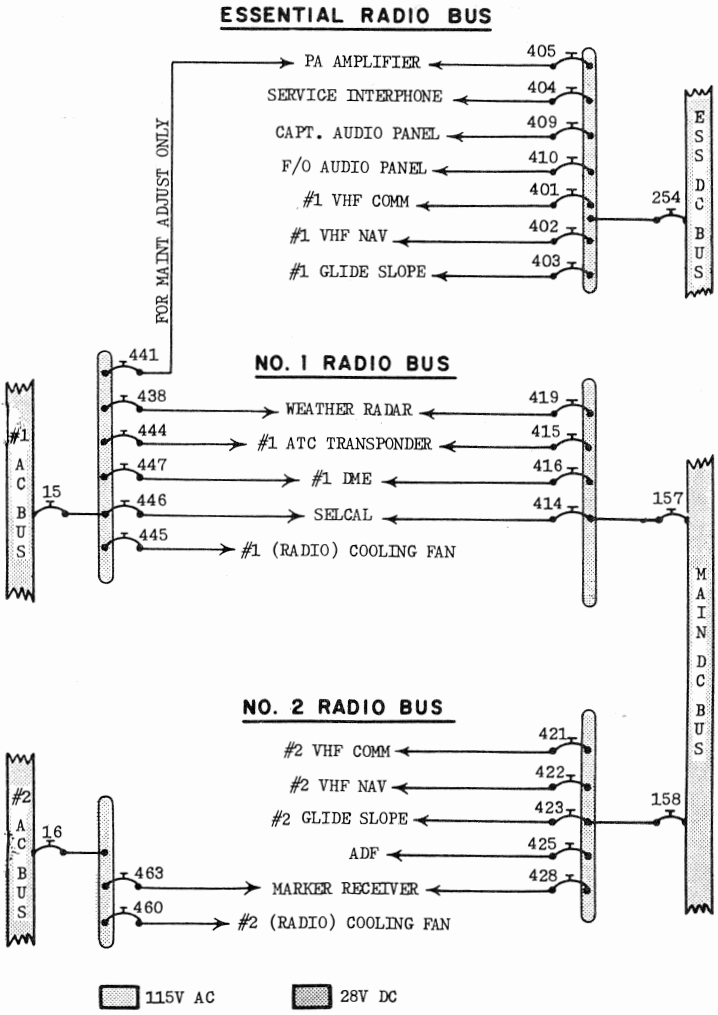
General

Electrical power for operation of the radio equipment is supplied by the No. 1 and No. 2 AC buses and the ESS and main DC buses. Power supplied by these buses is distributed to the radio equipment through three radio buses that supply four circuit breaker panels located on the forward edge of the radio rack. Airplane power is supplied directly to these radio buses through circuit breakers (no radio master switches).

COMMUNICATIONS SYSTEM DESCRIPTION

RADIO POWER SYSTEM (cont'd.)

Schematic



NOTE: NUMBERS ABOVE CIRCUIT BREAKERS CORRESPOND TO NUMBERS ENGRAVED ON CIRCUIT BREAKER PANELS.

COMMUNICATIONS SYSTEM DESCRIPTION

FLIGHT INTERPHONE SYSTEM

This system permits intercommunication between each crewmember station, including the observer and the external power control panel. Audio selector panels are provided at the Captain's, F/O's, and observer's stations. The headset receptacle at the external power panel connects to the Captain's panel. Each audio selector panel has an integral isolation amplifier that provides voice amplification at each station during interphone operation.

When a microphone selector is positioned to NORM INT, either the hand mike or the oxygen mask mike can be used; however, if the mask mike is used, the mask mike push-to-talk switch at the respective station must be actuated. (Push-to-talk switches are located on the Captain's and F/O's control wheel horns and on the observer's lighting panel below his/her audio selector panel.)

When a microphone selector is positioned to EMER INT, the hand mike is disconnected and the mask mike becomes continuously "hot". This allows the mask mike to be used without actuating the push-to-talk switch.

The interphone system can be used for two-way conversation only between those crewmembers who have their mike selector switches in either the NORM INT or EMER INT position. For ground-to-cockpit communication the Captain's mike selector must be in either the NORM or EMER INT position. This permits the Captain or any other crewmember whose mike selector is in an INT position to communicate with the ground.

A two-position (PA/NORMAL) oxygen mask mike selector switch is provided at both pilots' consoles. In the NORMAL (guarded) position, the flight interphone system operates as described previously. In the PA (passenger address) position, either pilot can make a PA announcement while wearing his/her oxygen mask. However, the mask mike is not connected to the PA system unless the respective push-to-talk switch is actuated, regardless of the mask mike selector position (NORM or PA). An amber light (labeled PA), located on both pilots' consoles, illuminates any time the respective oxygen mask mike selector switch is positioned to PA.

Interphone power is supplied by the ESS DC bus. Airplanes with C/B #469 and #470 activated are simultaneously supplied power from ESS DC bus and main DC bus.

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COMMUNICATIONS SYSTEM DESCRIPTION

SERVICE INTERPHONE SYSTEM

This system permits intercommunication between the following stations:

- Cockpit pedestal
- Forward and aft F/A stations (2)
- L. H. wheel well
- Refueling panel
- Ground communications panel (near external power receptacle)
- Aft stair area
- Vertical stabilizer "bullet"
- Left and right engine struts (2)

A service interphone switch, located above the RB circuit breaker panels, provides ON/OFF control of the 7 Maintenance interphone jacks. With the switch in the OFF position, the cockpit handset and the forward and aft F/A handsets remain operative.

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COMMUNICATIONS SYSTEM DESCRIPTION

PASSENGER ADDRESS SYSTEM

The PA system consists of an amplifier, speakers installed at various locations throughout the passenger cabin, a single PA monitor speaker in the cockpit, and 3 public address microphone stations. Signal input to the PA system can originate from the cockpit PA or crew oxygen mask microphones, or from the forward or aft F/A station microphones. However, a priority network permits the cockpit microphone to override both F/A microphones.

A switch at the forward F/A station, labeled PASSENGER ADDRESS HI/LO, permits selection of passenger address system volume.

A monitor speaker control switch, located on the overhead panel, provides ON/OFF control of the cockpit speaker.

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COMMUNICATIONS SYSTEM DESCRIPTION

COCKPIT/CABIN/GROUND CALL SYSTEMS

There are three basic systems installed on the airplane: a ground crew call system, a crew call system, and a F/A call system.

A cockpit-to-ground call button, labeled ground call, is provided on the pilots' overhead panel. When this button is depressed, a horn will sound in the nose wheel well.

A F/A-TO-CREW combination light and call button, labeled crew, is provided at the forward and aft F/A stations and a switch labeled crew call is provided at the ground communications panel (near external power receptacle). When one of these switches is actuated, a single stroke chime will sound in the cockpit. The blue combination light and call button labeled STEWARD CALL will also illuminate if the actuated switch was one of the F/A-TO-CREW call buttons.

NOTE: The blue light in the cockpit will remain illuminated only while the crew call button in the cabin is depressed.

The F/A call system has three mechanical chimes located in the cabin, one forward, one center, and one aft. A CREW-TO-F/A combination light and call button, labeled STEWARD CALL, is located on the pilots' overhead panel. When the button is depressed, a single stroke will sound on the chimes and 2 green lights (one at the forward F/A station and one at the aft F/A station) will illuminate. Reset buttons are provided adjacent to these lights and will cancel the lights when depressed.

A F/A call button is provided on each of the PSU's which will sound a double stroke on the chime when depressed. The passengers' call button and a green light at each F/A station will also illuminate. The lights are extinguished by pulling out on the passenger's call button. The chimes will sound single stroke when either of the passenger signs, SEAT BELTS or NO SMOKING, is turned ON.

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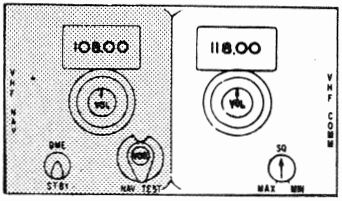
COMMUNICATIONS SYSTEM DESCRIPTION

VHF COMMUNICATIONS SYSTEMS

General Description

The airplane is equipped with two completely independent VHF communications transceivers, each consisting of a receiver, transmitter, antenna, and remote control panel. The units are mostly transistorized and require only DC power. The systems operate in the frequency range of 118.00 to 135.95 MC in increments of 0.05 MC's, providing 360 channels. The receivers are equipped for SELCAL operation. The control panels are located on the pedestal. Each panel has a conventional frequency selector and volume control knob. A squelch control knob is provided on each control panel that permits a variable selection of squelch between MIN and MAX.

The No. 1 antenna is located on the bottom center of the fuselage forward of the wing leading edge. The No. 2 antenna is located at the top of the vertical stabilizer bullet.



Operation

When selecting a new frequency channel, wait approximately 6 seconds to allow shift mechanism to complete cycle before attempting transmission.

When transmitting, hold the face of the microphone vertically, square to lips no more than 1/2-inch away, and speak directly into the microphone.

Due to VHF antenna location, blind spots may be experienced with VHF communications at certain points on the airport surface. If this condition exists, attempt operation with the other VHF system. If this is unsuccessful, communication can usually be restored by moving the airplane slightly.

If unable to receive a transmitting station (as advised by other receivable communication), turn squelch to MIN and make a further attempt. (The range of VHF reception will be appreciably increased.)

Precipitation static can be reduced appreciably by reducing airspeed. (The rate of build-up of a static charge varies with the cube of the airspeed.)

(cont'd.)

COMMUNICATIONS SYSTEM DESCRIPTION

VHF COMMUNICATIONS SYSTEMS (cont'd.)

Operation (cont'd.)

In the event there is no VHF communications reception, perform the following steps until the fault has been isolated. Isolate components ONE AT A TIME.

- Check VHF Comm C/B's (No. 1 VHF Comm C/B #401, No. 2 VHF Comm C/B #421).
- Unplug each cockpit mike (normal interphone and oxygen mask).
- Place each audio selector in NORM INT position.
- Isolate each radio, one at a time, by tripping the respective VHF Comm C/B. If malfunction is corrected, leave C/B tripped for defective radio.
- Pull C/B for each interphone audio panel individually (Captain's audio #409, F/O audio #410).

If isolation attempt is unsuccessful, VOR receiver may be used with VHF transmitter for communications.

COMMUNICATIONS SYSTEM DESCRIPTION

SELCAL

General Description

SELCAL, short for Selective Calling, is a system whereby ground radio facilities, when appropriately equipped, can emit a radio signal which will trigger a visual and aural signal in the cockpit when the station desires to communicate. SELCAL relieves the crew of having to maintain a continuous aural listening watch on Company frequencies. It is connected to both VHF communication receivers with a separate signal lamp for each receiver located on the SELCAL lights panel on the pedestal. A chime is actuated simultaneously with either light. When a ground station signals the airplane by SELCAL, one of two signal lamps (indicating which VHF is being used) will continue to flash and the chime will continue to sound until the respective SELCAL signal lamp is depressed.

Operation

To standby on SELCAL:

- VHF No. 1 or VHF No. 2 Freq. Selector - Set to proper route frequency.
- Volume Controls - Adjusted to desired level.
- VHF No. 1 Comm or VHF No. 2 Comm Switches - OFF.
- Monitor SELCAL chime and lights.
- When alerted by SELCAL light and/or chime, set microphone selector switch and audio panel selector switch to VHF signaled and depress respective signal lamp.

  NOTE: If desired, SELCAL standby may be accomplished with VHF No. 1 Comm and VHF No. 2 Comm switches ON and respective volume controls rotated full counterclockwise.

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COMMUNICATIONS SYSTEM DESCRIPTION

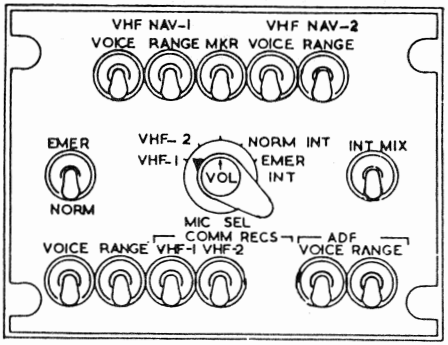
AUDIO SELECTOR SYSTEM

General Description

Three audio selector panels, located at the Captain's, F/O's, and observer's station are provided. These panels provide a means of selecting any combination of radio and interphone communications.

Loudspeakers located above the Captain's and F/O's station are provided to permit monitoring radio and interphone communications without headsets. The speakers are controlled individually by an ON/OFF switch and volume control knob located on the face of the respective speaker.

Controls & Indicators



Audio Selector Panel

Toggle Switches

These toggle switches connect the audio signals from various radio equipment to the audio panel amplifier. Any one of a combination of audio facilities can be monitored. Output of the audio amplifier is directed to the associated headset and in addition for the Captain and F/O to the loudspeakers. The VHF navigation and ADF receivers voice or range filter switches provide the respective filtering for either voice or range monitoring.

Microphone Selector Switch

The microphone selector switch, located on each audio selector panel, is a multi-position rotary-type switch that provides a means of connecting the microphone to a desired transmitter or selecting the normal or emergency intercommunications systems.

Audio Volume Control

The audio selector panel volume control is located in the center of the microphone selector switch. The control may be used to adjust the audio level of all sources being monitored.

(cont'd.)

COMMUNICATIONS SYSTEM DESCRIPTION

AUDIO SELECTOR SYSTEM (cont'd.)

Controls & Indicators (cont'd.)

Emergency/Normal Switch

This switch in the EMER position permits monitoring of incoming audio signals in the event that the integral transistorized amplifier is inoperative. In this position, the amplifier is bypassed and the crewmembers will be able to hear audio signals but at a reduced volume. The toggle switch for the desired receiver must be ON and all other toggle switches OFF with the emergency/normal switch in the EMER position. The switch is normally safety-wired to NORM.

Interphone Mix

Placing this switch to the INT MIX position permits a crewmember to monitor all cockpit interphone (NORM or EMER) transmissions while his/her own microphone selector is positioned for air-ground-air communication on VHF 1 or VHF 2. In the OFF (aft) position, only the normal side tone for the selected transmitter(s) and the receivers being monitored are heard.

COMMUNICATIONS SYSTEM DESCRIPTION

COCKPIT VOICE RECORDER

General Description

The voice recorder system consists of a recorder unit, a control panel, and four audio pickups. The recorder unit records the latest 30 minutes of cockpit audio on a loop of magnetic tape. (Sounds older than 30 minutes ar automatically erased to permit continuous reuse of the tape.) The four audio inputs are recorded from an area microphone (located aft and left of the control panel), from the outputs of the Captain's and F/O's audio isolation panels, and from the PA system. The recorder picks up the audio (communications and navigation reception, side tone, ICS), at each isolation panel from the circuits selected at that panel, picks up cockpit sound from the cockpit area mike and PA announcements from the PA amplifier. The four inputs are recorded through four separate recorder heads onto the single tape strip whenever ESS AC power is supplied. (Circuit protection is provided by the voice recorder C/B #26 on Panel B-1.) The system will not pick up the audio from circuits not selected (e.g., a VHF signal that is tuned in but not selected for monitoring will not get through to the recorder).

The recorder unit is located on the floor behind the last left-hand passenger seat in a water-sealed case. It contains the automatic erase heads, recorder heads, monitor heads, tape wind mechanism, and the magnetic tape loop. A monitor jack similar to the headset jack on the voice recorder control panel is provided on the recorder unit. The output from this jack is the same as that received from the headset jack on the recorder control panel. No tape playback feature is provided in the aircraft (the tape must be removed from the unit and installed on a special player to read the tape).

Operation

Ground Test

Depress and hold test button.

Test meter deflection in green band indicates satisfactory voice recorder operation.

Controls & Indicators

Voice Recorder Control Panel

The voice recorder control panel is located aft and to the left of the overhead panel and contains the cockpit area microphone, a test meter, a test button, and a headset monitor jack. When the test button is depressed and held, in about one second the test meter should show steady deflection into the green band. This indicates that a test tone is being recorded through the area mike recording head. (This test does not ensure that the area mike is operative or that any of the other three audio pickups and/or recorder heads are operative.) Audio input into the recording system at any point should not cause test meter needle deflection. The headset monitor jack is provided for maintenance test. It permits monitoring of the test tone. The only stored information which it can read is that which is one second old, since the arrangement of the recorder heads is erase-record-monitor in that order.

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COMMUNICATIONS SYSTEM DESCRIPTION

ELECTRONIC EQUIPMENT COOLING SYSTEM

This system provides a positive flow of cooling air for the electrical and electronic equipment located in the radio rack. Cabin air is drawn through the top of the radio rack and flows to the bottom of the rack passing over the various units. The air is collected at the bottom of the rack and is discharged into the underfloor area.

To provide a flow of cooling air two equipment cooling blowers are installed in the discharge duct upstream of the discharge ports. However, only one fan operates at any one time, normally the No. 1 fan operates continuously whenever power is available to its radio bus. If the No. 1 fan fails, or its electrical connector is not hooked up, the No. 2 fan will automatically come on.

NOTE: The radio cooling fan fail light will illuminate only if both fans have failed or if either fan electrical connector is not hooked up.

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AUTO FLIGHT SYSTEM DESCRIPTION

GENERAL DESCRIPTION

The BAC 1-11 (400 Series) aircraft use an Elliot E2000 autopilot. The autopilot, as described in this chapter, provides two basic and independent modes of operation:

- Complete "Autopilot" control about the three axes of the airplane. However, rudder inputs are limited to those generated by the yaw damper section of the autopilot, and

- Damping only in yaw.

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AUTO FLIGHT SYSTEM DESCRIPTION

AUTOPILOT

General Description

The autopilot provides for automatic heading and attitude control, automatic capture of preset headings, altitude hold, and automatic capture and tracking of an ILS localizer and glideslope or selected VOR radials.

Electrical power for autopilot operation, except for the pitch monitor and autopilot disengaged light, is three-phase, 115-volt AC from the No. 2 AC radio bus with circuit protection through the autopilot circuit breaker. The autopilot disengaged warning light is powered by the No. 1 DC radio bus through the autopilot warning circuit breaker. The pitch monitor, torque limiter adapter, is powered by the No. 1 AC radio bus through the autopilot monitor circuit breaker. Additional circuit protection is provided by four fuses on the front of the autopilot power junction box in the radio rack. DC power for certain functions of the autopilot is provided by rectifiers within the power junction box.

Each control axis of the autopilot operates the respective control surface through a servo/clutch mechanism which is connected to the control cables through engage and overload slip clutches. Autopilot control of any flight control surface(s) can be overpowered by the cockpit manual controls. Autopilot control of the other control surface(s) is not affected while one or more axes is being overpowered. The amount of force required to override elevator servo is 45-50 lbs; aileron servo is 35-40 lbs; and rudder servo (autopilot yaw damper) is 80 lbs.

Pitch and roll reference for the autopilot is supplied by the No. 2 vertical gyro. Pitch intelligence for the pitch monitor is provided by the No. 1 vertical gyro. Signals for directional guidance (ailerons) are provided by the First Officer's compass system. Rudder movement during a turn to correct for any tendency of the airplane to skid or slip is controlled by the yaw damper section of the autopilot.

All radio information supplied to the autopilot is from the No. 1 (Captain's) VHF NAV receiver and/or the No. 1 Glideslope receiver.

Control surface displacement rate (autopilot gain) is automatically adjusted for changes in airspeed and altitude. This is accomplished through the air data sensor which also provides static pressure signals for constant altitude control and autopilot desensitization during coupled approaches.

During autopilot operation, any sustained displacement of the elevator surfaces is automatically trimmed out by an electric servo motor that operates the stabilizer trim mechanism. This assures a constantly trimmed stabilizer to preclude objectionable pitch transients when disengaging the autopilot. A friction clutch is provided on the output shaft of the servo motor to permit the pilot to override the auto-pitch trim system. Approximately 20 lbs. of force is required to actuate the clutch.

A pitch monitor, torque limiter adapter, is incorporated into the autopilot to protect against autopilot malfunctions that may result in abrupt pitch changes. The monitor compares autopilot demands against elevator response to these demands and acts as a fault command limiter to limit the maximum "G" loading to ± 1 "G". The monitor will automatically disconnect the autopilot before excessive "G" forces can develop. An ON/OFF control is not provided for the pitch monitor. It is normally in operation whenever the autopilot is engaged.

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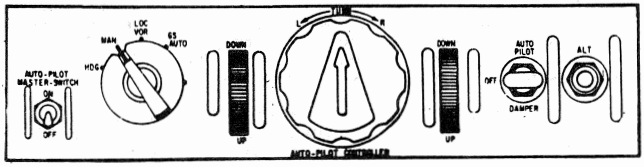
AUTO FLIGHT SYSTEM DESCRIPTION

AUTOPILOT (cont'd.)

Autopilot Control Panel

Autopilot master switch and controls for engaging the autopilot, autopilot yaw damper, altitude hold, manual turn and pitch maneuvering (with autopilot), and selecting autopilot mode of operation are located on the Autopilot Control Panel illustrated below.



(Pedestal)

Autopilot Master Switch

This two-position ON/OFF switch controls power supplies to all of the autopilot components.

Autopilot Engage Switch

This switch with AUTOPILOT/OFF/DAMPER positions is used to engage the basic autopilot or to engage the autopilot yaw damper as described in Section 14-25 of the chapter. The switch is solenoid-held in both the AUTOPILOT and DAMPER positions.

The autopilot cannot be engaged (engage solenoid will not energize to hold the switch ON), unless the turn knob is in its detent, the mode selector is in MAN, and all of the basic requirements for autopilot operation exist (power to autopilot power to vertical gyros, etc.). During operation, the switch will automatially return to OFF if an abnormal condition is sensed by one of the interlock circuits.

On engagement, the autopilot will maintain the pitch attitude and magnetic heading at which the airplane was flying at the instant of initial engagement. Since the autopilot is synchronized, it can be engaged while the airplane is banked, in which case the airplane will slowly roll to wings level and maintain the heading that existed at time of engagement. However, it is recommended that the autopilot be engaged when the airplane is in a wings-level attitude (or near thereto), because if engaged in a bank, the autopilot bank limits will be increased for about 6 seconds.

(cont'd.)

AUTO FLIGHT SYSTEM DESCRIPTION

AUTOPILOT (cont'd.)

Autopilot Control Panel (cont'd.)

Autopilot Engage Switch (cont'd.)

While the autopilot will continue to hold the pitch attitude at time of engagement, if engaged while in a nose-up or nose-down attitude and the autopilot pitch trim wheels are then used to level off at desired attitude, the amount of pitch attitude change subsequently available will be reduced by the amount of the original pitch angle at time of engagement. Therefore, if engaged during a climb or descent and autopilot pitch trim wheels are used to level off, it is recommended that the autopilot be turned OFF and back ON after level-off at desired altitude in order to restore the full normal pitch limits of the autopilot control. The pitch limits are not affected if the autopilot Altitude Hold feature is used to establish level flight.

A circuit is provided to prevent the possibility of transient surface deflection (autopilot "bump") upon disengagement of the autopilot. This is accomplished by driving aileron and elevator servo torque to zero immediately upon disengagement and keeping the torque at zero until the servo clutches mechanically disengage.

Altitude Hold Switch

This two-position ON/OFF switch provides selection of constant altitude control. In the ALT position, the autopilot, through signals from the air data sensor, will maintain level flight at the pressure altitude at which the switch was engaged. The switch is solenoid-held to the ALT position and will automatically return to the spring-loaded OFF position for any one of the following reasons:

- Autopilot is disconnected.
- Autopilot system electrical power fails.
- Autopilot mode selector is positioned to GS AUTO mode and the glideslope is intercepted.

The autopilot manual pitch trim wheels are declutched when Altitude Hold is engaged.

Turn Knob

This knob permits coordinated turns to be established in the desired direction through the autopilot command channels when the autopilot is in Manual mode. The amount of displacement from the center detent determines the angle of bank. Once established, the autopilot holds the airplane in the selected angle of bank. Placing the knob in the center position will again return the airplane to level flight and the airplane will maintain the heading that existed when the turn knob was returned to the center position. The knob must be in its center detent before the autopilot can be engaged. If the knob is rotated out of its center detent when operating in any mode other than Manual, the autopilot will automatically return to the MAN position.

Pitch Trim Wheels

Rotating the pitch trim wheels varies the airplane pitch attitude by use of the autopilot. The change in pitch attitude is proportional to the direction and amount of trim wheel rotation. The trim wheels are declutched whenever Altitude Hold is engaged or whenever GS AUTO mode is selected and the system is coupled to the glideslope beam.

(cont'd.)

Supplied by Jeppesen Sanderson

AUTO FLIGHT SYSTEM DESCRIPTION

AUTOPILOT (cont'd.)

Autopilot Control Panel (cont'd.)

Mode Selector

This four-position rotary switch permits selection of the desired mode of autopilot operation. The switch positions determine the source of reference input signals to the autopilot. When selecting any position other than MAN, certain interlock circuits must be satisfied before the switch is solenoid-held in the selected position. The switch is spring-returned to the MAN position if an interlock is opened or the autopilot is disengaged. Switch positions provide the following modes of autopilot operation as follows:

- MAN (Manual)

  In this position, the autopilot will maintain the magnetic heading that exists when the autopilot is engaged. The autopilot actually "clutches" to magnetic heading about 3 seconds after engagement. If the airplane is in a bank at the time of engagement, the autopilot will roll the airplane back to wings-level. Heading information is supplied by the First Officer's directional gyro. The autopilot will respond to inputs from the turn knob and pitch trim wheels. When the turn knob is moved out of its detent, the autopilot "unclutches" from the existing heading and then "reclutches" to whatever heading exists when the knob is returned to its detent. Altitude hold can be used in this mode, if desired.

- HDG (Preselected Heading)

  In this position, the autopilot heading reference is the heading that is set by the Captain's CDI HDG knob. The autopilot turns the airplane to cancel out the difference that exists between the airplane heading, at the time this mode is selected, and the preselected heading. If the maneuver knob is moved out of the turn detent to change the heading in this mode, the mode selector will return to MAN. The HDG knob on the Captain's CDI can be turned while in the HDG mode to change heading, if desired. Altitude Hold can be used in this mode, if desired.

- LOC/VOR

  In this position, the autopilot will automatically turn the airplane to capture and track a localizer front course (inbound only) or a VOR radial, provided the airplane is within a certain position relative to the selected course. The desired course is set with the COURSE crank on the Captain's CDI. The airplane must be flown, "hand-flown" or by autopilot in MAN or HDG mode, to a certain position relative to the selected course, in terms of CDI bar deflection, about 1 dot displacement on VOR, and about 2 dots displacement on localizer, and the desired course intercept angle must be established.

  Once the airplane is within the specified position relative to the selected course, the autopilot begins to "capture" the course using a combination of compass and radio signals. The compass signal for this function, taken from the Captain's CDI, is actually the difference between the heading shown on the CDI card and the magnetic heading of the selected course, VOR radial or localizer front course. The radio signal, lateral displacement from selected course, is supplied by the No. 1 Captain's VHF NAV receiver through the Captain's CDI.

(cont'd.)

AUTO FLIGHT SYSTEM DESCRIPTION

AUTOPILOT (cont'd.)

Autopilot Control Panel (cont'd.)

Mode Selector (cont'd.)

- LOC/VOR (cont'd.)

When the airplane reaches a specific point relative to beam center, the autopilot switches from the "capture" to the "track" phase. Once in the "track" phase, the autopilot continues to track the selected course and provides automatic wind drift correction; i.e., the autopilot establishes the magnetic heading required to keep the airplane on course.

When tracking a VOR radial, the radio signals to the autopilot are automatically smoothed out by a "data smoother" network for passage through the VOR "cone of confusion" to prevent the airplane from "wallowing" due to rapid fluctuations in the VOR signals near the cone. Data smoothing is accomplished by a filter which passes only long term signals. The network is activated in the "capture" and "track" phases when a predetermined signal strength is received. Altitude Hold is available in this mode, if desired.

- GS AUTO

In this position, the autopilot approach "coupler" is activated and it will automatically "lock onto" and track the glideslope beam while continuing to track the localizer as explained earlier. The selector must be placed in this position while the airplane is below the glideslope, that is, before intercepting the glideslope inbound. When this position is selected, the glideslope annunciator moves from OFF to ARM. Additionally, the Marker switch should be positioned to LO. If the airplane is very near the glideslope or if no glideslope signal exists, the selector will not stay in this position. If GS AUTO is selected after flying through the glideslope, the selector will remain in this position, but the autopilot will not attempt to capture the glideslope.

Within 2 dots displacement of the deviation bar, the airplane turns to intercept the center of the localizer. Upon intercepting the glideslope, the glideslope annunciator moves from ARM to ENG. At this time, the Altitude Hold trips off, airplane pitches down about 2-1/2° to start tracking the glideslope, if Altitude Hold was ON (if Altitude Hold was OFF, the airplane will be guided onto glideslope by beam error signal), "synthetic beam damping" signal becomes effective (to compensate for wind shear down the glideslope), and pitch trim wheels become inoperative.

Upon crossing the outermarker, the desensitization circuit is activated to reduce the sensitivity of the autopilot signals. Full desensitization is completed after a 1,000-foot descent in altitude or upon crossing the middle marker, whichever occurs first. When fully desensitized, the sensitivity of the localizer is reduced to 50% of normal, glideslope reduced to 25% of normal, bank limits are reduced from 30° to 10°, and pitch limits are reduced from 10° to 4°. As the airplane crosses over the middle marker, complete desensitization occurs, if it has not occurred prior to this point.

NOTE: Full sensitivity can be immediately regained any time after desensitization begins by selecting MAN mode on the Mode Selector.

AUTO FLIGHT SYSTEM DESCRIPTION

AUTOPILOT (cont'd.)

Miscellaneous Controls and Indicators

Automatic Go-Around (if activated)

During a coupled approach, this function automatically pitches the airplane up 7° from its existing attitude if the following conditions are met:

- Autopilot is in GS AUTO mode.
- Radio Altimeter indicates below 500 feet.
- No. 1 throttle is advanced for missed approach.

Go-Around Annunciator

Illuminates amber if radio altitude is below 500 feet and GS AUTO is selected.

When No. 1 throttle is advanced to TAKEOFF position:

- A/P mode selector returns to MAN and annunciator switches from amber to green.
- Autopilot pitches aircraft up 7° from existing attitude and aircraft climbs out on heading.
- Annunciator goes blank when autopilot is disengaged.

Autopilot Disconnect Buttons

An autopilot disconnect button is located on the outboard "horn" of each pilot's control wheel. Depressing either of these buttons will disengage the autopilot.

Autopilot Disengaged Warning Light

A red autopilot disengaged warning light is located on each pilot's instrument panel. Both lights will illuminate intermittently whenever the autopilot is disengaged by any means other than by a control wheel disconnect button. Loss of 28-volt DC warning light power, normally supplied through the autopilot warning circuit breaker, will cause both warning lights to illuminate from alternate power source. Resetting the circuit breaker, if tripped, or depressing either control wheel disconnect button will extinguish the lights. This feature is provided to protect against operating unknowingly without the warning lights to warn of a cutoff.

(cont'd.)

AUTO FLIGHT SYSTEM DESCRIPTION

AUTOPILOT (cont'd.)

Miscellaneous Controls and Indicators (cont'd.)

Three-Axis Trim Indicator

This instrument is located on the Captain's instrument panel and provides through three meter movements a visual indication of:

- Autopilot servo and control surface position synchronization prior to autopilot engagement.

- The direction of force being held on the respective control surface by the autopilot after autopilot engagement.

Glideslope Annunciator

This device is located on the Captain's instrument panel and has three positions: OFF/ARM/ENGage. The annunciator displays OFF until the GS AUTO position is selected with the Mode Selector, and the No. 1 NAV receiver is tuned to an ILS frequency; then, the annunciator moves to ARM to show that the approach coupler is armed for operation.

Upon intercepting the glideslope and as the coupler "locks on" to the glideslope, the annunciator moves to ENG. The annunciator will return to OFF when the autopilot Mode Selector is moved out of GS AUTO mode.

AUTO FLIGHT SYSTEM DESCRIPTION

AUTOPILOT (cont'd.)

Operation (On-the-Ground)

A condensed ground check to be used by the flight crew to ascertain satisfactory autopilot operation is presented below:

- No. 2 Auxiliary Hydraulic Pump - ON.
- Autopilot, Autopilot Warning, and Autopilot Monitor C/B's - CHECK IN.
- Autopilot Master Switch - ON.
- Engage Switch - AUTOPILOT.
- Autopilot Turn Knob and Pitch Wheels - CHECK. Check control response in all axes to autopilot commands.
- Altitude Hold - ENGAGE. Check that it will remain engaged.
- Autopilot Disconnect Button - DEPRESS. Disengage autopilot using either control wheel button.
- Autopilot Engage Switch - DAMPER.
- Apply force to rudder pedals and check that rudder servo resists pedal movement.
- Disengage damper using other control wheel button.

To ground check the Go-Around mode:

- Test radio altimeter.
- Engage autopilot, select GS AUTO, and check go-around annunciator amber.
- Advance No. 1 throttle, check mode selector returns to MAN, annunciator switches to green, and control column moves aft.
- Press autopilot control wheel disconnect button. Autopilot should disengage, control column should return to neutral, and green annunciator should extinguish.

NOTE: Once go-around is armed, it can only be disarmed by disengaging the autopilot. Retarding the throttles will not affect go-around mode.

AUTO FLIGHT SYSTEM DESCRIPTION

AUTOPILOT (cont'd.)

Operation (In Flight)

Engaging Yaw Damper

The autopilot yaw damper is to be OFF for takeoff and landing, but may be engaged after takeoff during initial climb. Before engaging damper, rudder should be "in trim" and at or near center. The position of the rudder at the time of damper engagement becomes "zero reference" for the yaw damper system.

To engage damper, place autopilot engage switch to DAMPER position. Carefully guard control wheel disconnect button when engaging or disengaging damper.

Do not engage the autopilot below "minimum altitude for use of autopilot during enroute cruise". Refer to Chapter 2 - LIMITATIONS in this manual.

Although the autopilot maintains automatic synchronization with the attitude of the airplane and may therefore be engaged at any time, it is recommended that the wings of the airplane be level with the horizontal and the airplane trimmed manually for "hands off" flight, no deflection of aileron or elevator autopilot trim meters, in the existing attitude, i.e., climb, level, or descent, before engaging the autopilot.

Carefully guard controls and control wheel disconnect buttons when engaging or disengaging autopilot. Engage autopilot as follows:

- Manually trim airplane. Check aileron, rudder, and elevator trim meters approximately centered.
- Check turn knob in center detent and mode selector in MAN.
- Place autopilot engage switch to AUTOPILOT.
- Retrim airplane to center trim meters, if necessary.
- Turn ON altitude hold, if desired.

To Change Attitude of Airplane (MAN Mode)

If the mode selector is left in MAN position, the airplane will continue to hold the heading at the time of autopilot engagement. To change heading, rotate the autopilot turn knob in the desired direction. If a change in pitch attitude is desired, turn altitude hold OFF, if ON, and rotate pitch trim wheels forward to descend or aft to climb. To make climbing or descending turns, rotate both the turn knob and pitch trim wheel in desired direction. To resume straight and level flight, return turn knob to center position and rotate pitch trim wheels until airplane returns to level flight. Re-engage altitude hold, if desired.

(cont'd.)

AUTO FLIGHT SYSTEM DESCRIPTION

AUTOPILOT (cont'd.)

Operation (In Flight) (cont'd.)

To Use Preselect Heading (HDG) Mode

To automatically establish a preselected heading with the autopilot, proceed as follows:

- Check Mode Selector in MAN position.
- Using the Captain's CDI HDG knob, set the HDG cursor on the desired new heading.
- Turn the Mode Selector to HDG position.

The autopilot will turn the airplane to, and hold, the preselected heading. Altitude hold is available, if desired.

To Capture and Track VOR Radials (LOC/VOR Mode)

To have the autopilot automatically turn the airlane to capture and track a VOR radial, proceed as follows:

- Select appropriate VOR frequency on Captain's #1 VHF NAV receiver and identify facility.
- Using COURSE crank on Captain's CDI, set desired course in CDI window.
- Manually fly the airplane, by "hand-flying" or using autopilot MAN mode, to establish desired course intercept angle. For best results, intercept angle should not exceed 30°.
- Place Mode Selector to LOC/VOR position. The airplane will continue on established intercept course until reaching a point about 2 dots displacement on CDI bar at which it will turn the airplane to capture and track course. If the turn knob is moved out of turn detent at any time, the mode selector will return to MAN position.
- During VOR station passage, radio signals are automatically smoothed out when nearing the "cone of confusion" to prevent the airplane from wallowing due to rapid fluctuations in the VOR signals near the cone. If a different course will be followed outbound from the station, the new course may be selected while in the "cone of confusion". The airplane will turn to capture the new outbound course.

  NOTE: When selecting a new outbound course from station, the bank angle is limited to 30°. Therefore, if a large degree of course change is required, revert to MAN and use turn knob to capture outbound radial; otherwise, excessive "bracketing" may occur. Reverting to MAN will "wash out" any crosswind integration that has been put in while tracking inbound.

(cont'd.)

AUTO FLIGHT SYSTEM DESCRIPTION

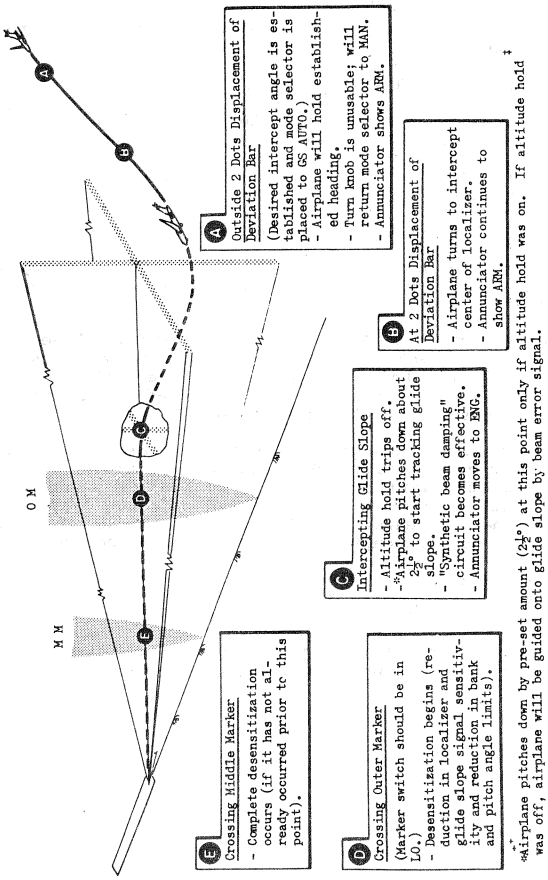
AUTOPILOT (cont'd.)

Operation (In Flight) (cont'd.)

Autopilot Coupled Approach (GS Mode)

The following pictorial shows the manner in which the autopilot performs an automatic approach, including automatic capture of the localizer.

MAJOR FUNCTIONS OF AUTOPILOT DURING COUPLED APPROACH


A
Outside 2 Dots Displacement of Deviation Bar
(Desired intercept angle is established and mode selector is placed to GS AUTO.)
- Airplane will hold established heading.
- Turn knob is unusable; will return mode selector to MAN.
- Annunciator shows ARM.
B
At 2 Dots Displacement of Deviation Bar
- Airplane turns to intercept center of localizer.
- Annunciator continues to show ARM.
C
Intercepting Glide Slope
- Altitude hold trips off.
- *Airplane pitches down about 2½° to start tracking glide slope.
- "Synthetic beam damping" circuit becomes effective.
- Annunciator moves to ENG.
D
Crossing Outer Marker
(Marker switch should be in LO.)
- Desensitization begins (reduction in localizer and glide slope signal sensitivity and reduction in bank and pitch angle limits).
E
Crossing Middle Marker
- Complete desensitization occurs (if it has not already occurred prior to this point).
O M
M M
*Airplane pitches down by pre-set amount (2½°) at this point only if altitude hold was on. If altitude hold was off, airplane will be guided onto glide slope by beam error signal.

AUTO FLIGHT SYSTEM DESCRIPTION

AUTOPILOT (cont'd.)

Operation (In Flight) (cont'd.)

Disengagement

The autopilot or its yaw damper is normally disengaged by depressing either control wheel disconnect button. When this is done, the autopilot disconnect lights remain extinguished.

The autopilot alone will disconnect if the stabilizer trim wheels are moved rapidly; however, in the case of the disconnect lights, will illuminate (flash) and must be extinguished by depressing either control wheel disconnect button.

If the autopilot does not disengage when a wheel button is depressed:

- try the other wheel button, or
- manually position engage switch to OFF, or
- turn OFF the autopilot master switch.

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AUTO FLIGHT SYSTEM DESCRIPTION

AUTOPILOT YAW DAMPER

An autopilot yaw damper is incorporated on the airplane. It automatically positions the rudder as a function of yaw acceleration to improve airplane directional stability; more specifically, its primary purpose is to minimize "dutch roll" during manually or automatically controlled flight by providing rudder action at a rate proportional to the yaw acceleration of the airplane.

A yaw damper computer, mounted in the radio rack, contains a rate gyro, amplifier, power supply, and a mechanism for testing the system. The computer incorporates a bandpass filter which eliminates those unwanted frequencies resulting from fuselage bending and steady rate turns. The signals that pass through the bandpass filter are supplied through an amplifier to a selector valve which ports hydraulic control pressure to the damper actuator. The damper actuator in turn operates the rudder power unit.

The autopilot yaw damper is engaged by placing the autopilot engage switch to the DAMPER position. The autopilot then applies small rudder corrections, up to 1-1/2° of rudder deflection, through a servo-motor that is connected in parallel to the rudder pedal linkage.

Autopilot yaw damper authority is not influenced by flap handle position. Thus, autopilot yaw damper corrections will move the rudder pedals as the rudder moves and will oppose inputs to the system from the rudder pedals. The system is disengaged by depressing the autopilot disengage switch on either control wheel or by moving the autopilot engage switch to the OFF position.

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OXYGEN SYSTEM DESCRIPTION

GENERAL DESCRIPTION

Two independent integral oxygen systems are provided as follows:

- One system supplies the COCKPIT outlets.
- One system supplies the CABIN outlets.

In addition, three portable oxygen cylinders are installed as follows:

- One in the COCKPIT.
- Two in the CABIN.

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OXYGEN SYSTEM DESCRIPTION

COCKPIT OXYGEN SYSTEM

General Description

The cockpit utilizes a diluter-demand system. Each flight crewmember's station is provided with a diluter-demand regulator panel and a "sweep-on" type demand mask. Goggles are provided for use with the mask during a smoke or contaminated air emergency. A portable oxygen bottle is located at the aft left sidewall.

Oxygen Cylinder Assembly

The crew oxygen cylinder assembly consists of a cylinder located in the E & E compartment which is charged to a minimum of 1,500 PSI, a shutoff valve, and a direct reading pressure gauge.

To relieve excess pressure from thermal expansion, a safety disc on the bottle will blow out and discharge the oxygen overboard through a discharge line on the left side of the E & E compartment. The oxygen bottle must be removed from the aircraft for recharging.

Cylinder pressure indication is provided in the cockpit by a direct reading 0 - 2,000 PSI gauge on the F/O's side console.

Cockpit Shutoff Valve

The manual oxygen supply shutoff valve (slow opening) is located on the F/O's side console and controls the oxygen supply to all cockpit stations.

Pressure Reducing Regulator

A pressure reducing regulator is located beneath the F/O's side console and reduces the oxygen pressure to 70 PSI before it is delivered to the individual crew regulators.

Oxygen Regulator Panel

An automatic diluter demand oxygen regulator panel at each flight crewmember's station provides for all oxygen requirements from sea level to the maximum operating altitude of the airplane. The regulator receives oxygen at reduced pressure from the pressure regulator. The panel is edge-lighted and includes a flow indicator and three control levers as follows:

- Flow Indicator - The flow indicator is a float-type (bobbin) which indicates (by "blinking") the oxygen flow through the regulator.

- Supply Lever - The supply lever controls the oxygen supply to the regulator. The lever has ON-OFF positions. In the ON position oxygen is supplied to the regulator and in the OFF position the oxygen supply to the regulator is shut off to prevent any flow of oxygen from the regulator when not in use.

- Oxygen Diluter Lever - The regulator diluter lever has NORMAL and 100% positions. With the lever in NORMAL position the regulator automatically supplies, on demand, the proper mixture of oxygen and air at all altitudes. With the lever in 100% position, the air intake port is closed and pure oxygen is supplied on demand regardless of altitude.

- Emergency Lever - The lever has ON-OFF positions. When in the ON position, undiluted oxygen is supplied to the mask under positive pressure (regardless of diluter lever position).

(cont'd.)

OXYGEN SYSTEM DESCRIPTION

COCKPIT OXYGEN SYSTEM (cont'd.)

Crew Oxygen Masks

The Captain's and First Officer's stations have "sweep-on" Puritan-type quick-donning oxygen masks. The observer's station has the conventional quick-donning oxygen mask. The "sweep-on" type masks have replaceable soft rubber insert cups that will fit to any face size. The microphone is molded into the mask and the entire assembly normally stays with the airplane. The detachable face cup may be removed for sanitizing. The mask exhalation valves are spring-loaded closed so that a slight positive pressure is required when exhaling.

The conventional mask at the observer's station has a quick disconnect at the face piece which allows the face piece to be removed leaving the microphone and exhalation valve with the extention hose. Provisions exist to connect the Captain's and F/O's oxygen mask microphones into the passenger address system.

Cockpit Portable Oxygen Bottle

The cockpit portable oxygen bottle supply consists of a small oxygen cylinder assembly pressurized to a minimum of 1,500 PSI with outlets for both continuous flow and demand masks. The oxygen cylinder assembly includes a pressure gauge and a manual shutoff valve. The gauge indicates bottle pressure with the manual shutoff valve open or closed) A full face demand-type mask is attached with hose and threaded coupling. A continuous flow-type mask using a bayonet-type nipple may be attached to the bottle at the continuous flow receptacle. The cockpit portable cylinder is stored at the aft left cockpit sidewall.

Ground Checks

Check that shutoff valve is OPEN and check oxygen pressure. When opening the cockpit shutoff valves, do not apply a high force to the knob as this may damage the valve. After the valve is fully open, back off about 1/4 turn so that anyone attempting to open the valve will realize it is already open.

Check oxygen regulator panels set as follows:

- Supply Lever - ON. Leave observer's OFF when seat is not occupied.

- Oxygen Lever - 100%.

- Emergency Lever - OFF.

Each crewmember will check mask, harness adjustment, hose, and mask oxygen flow. Check mask microphone by placing microphone selector to EMER INT and calling other crewmember.

(cont'd.)

OXYGEN SYSTEM DESCRIPTION

COCKPIT OXYGEN SYSTEM (cont'd.)

Use of Oxygen

When using oxygen for non-emergency, move diluter lever to NORMAL. This will automatically supply proper mixture of air and oxygen and keep consumption of oxygen to a minimum. Return lever to 100% when use of oxygen is discontinued.

CAUTION: When closing any oxygen valve, turn handle until stem lightly bottoms. Further tightening of the valve may result in damage to valve seat.

Refer to Chapter 1 - EMERGENCY in this manual for specific emergency procedures involving use of oxygen.

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OXYGEN SYSTEM DESCRIPTION

CABIN OXYGEN SYSTEM

General Description

The passenger oxygen system supplies gaseous oxygen to the passengers and cabin crew by automatic mask presentation if cabin decompression occurs.

It also incorporates a provision for therapeutic oxygen supply from fixed socket and flow selectors adjacent to the mask storage assemblies on the passenger service units.

The major components of the passenger oxygen system are:

- Oxygen Cylinder Shutoff Valve,
- Pressure Gauge,
- Double Pressure Reducing Regulator,
- Barometric Control Valve,
- Ring Main, and
- Passenger Service Units.

Oxygen Cylinder Assembly

The passenger oxygen cylinder assembly consists of a large oxygen cylinder located in the E & E compartment and charged to a minimum of 1,500 PSI, a shutoff valve, and a direct reading gauge. A safety disc will relieve overpressure in the cylinder by venting the oxygen overboard.

Cylinder pressure indication is provided in the cockpit by a direct reading 0 - 2,000 PSI gauge on the F/O's side console.

Cabin Shutoff Valve

The cabin shutoff valve is a manually operated valve that controls the flow of oxygen to the passenger system. The valve is located on the F/O's side console.

Double Pressure Reducing Regulator

This regulator is capable of delivering either NORMAL (about 40 PSI) or EMERGENCY (80-100 PSI) oxygen pressure. The selection is automatically initiated by the barometric control valve, or manually by the flight crew.

Barometric Control Valve

This valve controls the output of the double pressure regulator, causing it to automatically deliver oxygen at EMERGENCY pressure when the cabin altitude reaches 14,000 feet.

If the cabin altitude remains between 14,000 and 17,000 feet, from 8 to 30 seconds, the regulator is automatically reset to deliver oxygen at NORMAL pressure. Oxygen at normal pressure will now be available at all cabin altitudes up to 17,000 feet until the crew terminates the flow. This can be done by pushing the green therapeutic oxygen system knob in once the cabin altitude is below 14,000 feet.

If cabin altitude exceeds 17,000 feet, the automatic resetting mechanism is rendered inoperative and EMERGENCY pressure is delivered continuously. If the cabin altitude descends below 17,000 feet, the resetting mechanism automatically reduces the oxygen pressure to NORMAL.

(cont'd.)

OXYGEN SYSTEM DESCRIPTION

CABIN OXYGEN SYSTEM (cont'd.)

Ring Main

This is the oxygen manifold which connects all of the passenger service units to the oxygen supply.

Pressure Gauge

A pressure gauge on the right overhead panel shows the oxygen pressure available to the ring main. It does not show pressure in the manifold unless either the red or green knobs have been actuated.

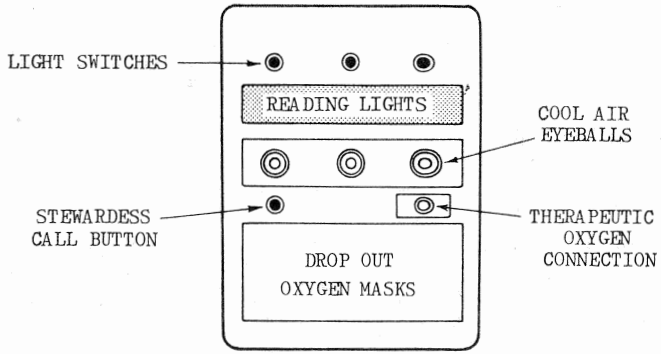
Passenger Service Units

Three types of passenger service units are installed as follows:

- The three-mask unit available above each normal passenger station;
- The two-mask unit available at the galley, forward F/A position, and both lavoratories; and
- The single-mask unit available at the aft F/A position.

Oxygen flow to the three-mask units is instantaneous and continuous whenever the masks drop, however, the other units must be activated by pulling the mask down to allow a spring-loaded check valve in the hose to open.

An isolation valve (red button) on all the units allows manual termination of the oxygen flow to all automatically presented masks, if desired, when the ring main pressure is normal. The therapeutic outlet cannot be shut off by use of the isolation valve.



(cont'd.)

OXYGEN SYSTEM DESCRIPTION

CABIN OXYGEN SYSTEM (cont'd.)

Therapeutic Supply

A therapeutic supply of oxygen at normal pressure is available at each three-mask passenger unit. This is achieved by pulling out the therapeutic supply (green) knob. The oxygen is available only if the cabin oxygen shutoff valve on the F/O console is open and an oxygen hose from a therapeutic mask is plugged into the therapeutic oxygen supply socket on the passenger service unit. The therapeutic oxygen supply can be stopped by pushing and holding in the supply knob until residual pressure in the ring main drops off. At this point, the valve will remain closed.

Oxygen Valve Manual Override Knob

Emergency oxygen can be provided by pulling out the oxygen valve manual override (red) knob. This action overrides the barometric control, drops the masks, and allows a continuous flow of oxygen to be delivered to the three-mask passenger units. Any time the oxygen valve manual override knob is activated to the OUT position the therapeutic supply (green) knob pops OUT. To reduce oxygen pressure to normal, or to reinstate automatic emergency oxygen control, the oxygen valve manual override knob must be pushed in. To completely terminate oxygen flow, the therapeutic supply knob must also be pushed in.

A pressure activated switch will illuminate a passenger oxygen light on the overhead panel and the fasten seat belts and no smoking signs in the cabin whenever emergency oxygen pressure causes the masks to drop.

Portable Oxygen Bottles

The cabin has two portable oxygen bottles, one located in the forward left hat rack and the other in the compartment just aft of the left lavatory. These are provided primarily for F/A use following decompression (cabin system should be employed for therapeutic use). Two constant flow outlets are located on the bottle, LO which is used normally and HI for use when necessary to employ for therapeutic use. Each bottle should be charged to a minimum of 1,500 PSI.

Ground Check

CAUTION: Oxygen should not be used in the vicinity of any form of open flame. Do not permit smoking near a person using oxygen.

Check shutoff valve OPEN (open slowly) and check two pressures.

Oxygen Drill

Both flight crewmembers will don oxygen masks as quickly as possible and place microphone selector switch to EMER INT. The Captain will contact the F/O through the mask microphone and the F/O will reply.

(cont'd.)

OXYGEN SYSTEM DESCRIPTION

CABIN OXYGEN SYSTEM (cont'd.)

Passenger Oxygen Mask Drop

Whenever any or all passenger oxygen masks drop and the use of oxygen is not required, assure that the oxygen valve manual override (red) knob and the therapeutic (green) knob on the overhead panel are pushed in and observe the following:

For flight above FL300, FAR's require automatic presentation of an oxygen mask for each passenger in the event of loss of cabin pressure. There are two ways to comply with this regulation in the event any or all of the passenger masks drop in flight:

- If only a portion of the masks drop and passenger load permits, move passengers to seats where masks have not dropped, or,

- Restrict flight to FL290 maximum, since ATC does not use FL300.

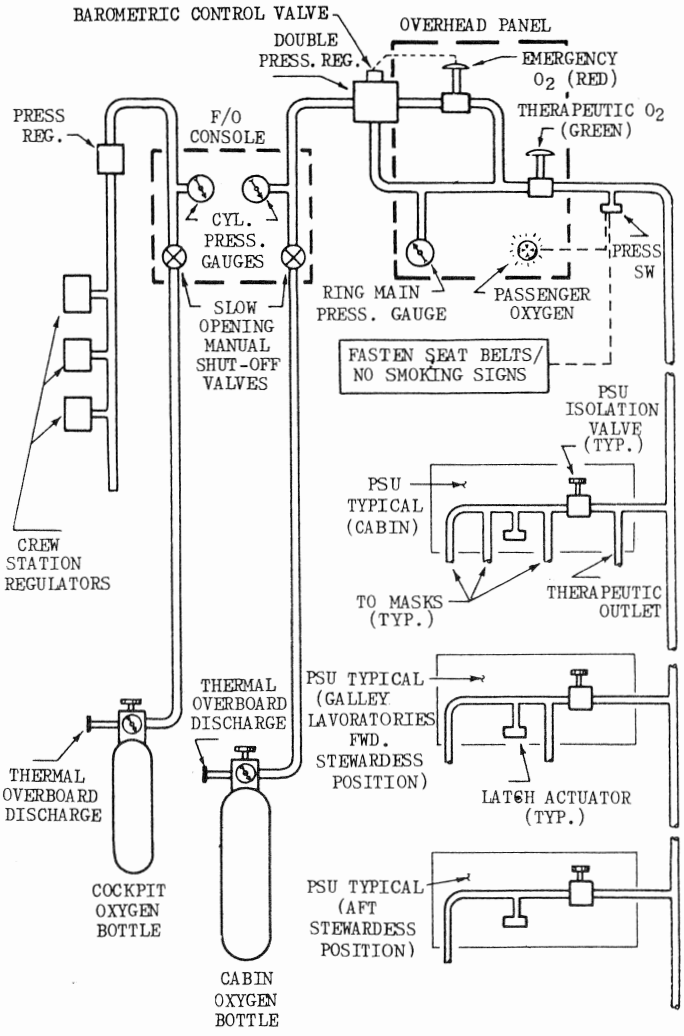
If the first course of action is followed, place masks at vacated seats in hat rack and close the control valve(s) (red button in PSU) for these masks. Leave mask hose connected. Do not permit smoking until 15 minutes after oxygen flow is stopped. If passenger oxygen is subsequently needed, pull red knob on overhead panel and make a PA announcement instructing passengers to don and use masks and to extinguish all cigarettes.

If drop occurs on the ground, Maintenance will repack masks. However, if drop occurs where Maintenance is not available, one of the above courses of action may be followed.

Enter in aircraft logbook any case of mask drop, giving seat location. Indicate whether masks were used.

OXYGEN SYSTEM DESCRIPTION

SCHEMATIC



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POWERPLANT SYSTEM DESCRIPTION

GENERAL DESCRIPTION

The airplane is equipped with two Rolls-Royce Spey 511-14 bypass turbojet engines, each housed in its own pod and mounted on struts (referred to as stubs) one on each side of the aft fuselage. Each powerplant is suspended on two beams and thrust is transmitted by a thrust strut from the front beam to the fuselage.

The engine is a continuous-flow gas turbine consisting of two axial flow compressors in series, a can-annular combustion section with ten interconnected, circumferentially arranged burner cans, four impulse-reaction turbine stages in series, and an exhaust section incorporating a thrust reverser. The 511-14 powerplant has a static rating of 11,400 lbs. thrust at sea level standard conditions. It is a modified version of the 510-14 engine which was rated at 11,000 lbs. thrust. Operation of the 511-14 engine at the lower thrust rating for takeoff is referred to as a "510 rating" takeoff.

The compressors, with their respective driving turbines, constitute two rotor assemblies designated low pressure (LP) and high pressure (HP) and referred to by the speeds at which they turn, N1 and N2 respectively. The N1 assembly consists of the first five stages of the compressor section connected by a shaft to the last two turbine wheels. The N2 assembly includes stages 6 through 17 of the compressor section connected by a hollow shaft to the two forward turbine wheels. Although the N1 shaft turns inside the N2 shaft, the two rotors are not connected mechanically, being related only as to airflow. The N1 compressor stages are much larger in diameter than the N2 stages and after the first five stages of compression, the airflow divides into separate primary and bypass streams. The inner (primary) stream is further compressed in the N2 compressor to provide energized air for combustion of the fuel sprayed into the burner cans. The bypass stream passes through an annular duct around the N2 compressor, combustion section and turbines, rejoining the hot primary gases in the exhaust stream. The combined gases then pass through the thrust reverser section and are expanded to atmosphere through the exhaust nozzle.

Internal cooling is achieved with bypass air and 5th stage compressor bleed air which, in addition to pressurizing oil seals, provides general cooling of the bearing areas. This air exhausts through the LP cooling air outlet in the side of the combustion case and is monitored by a Fenwall switch to provide engine overheat protection. Fifth stage air cools the 17th stage compressor disc. Seventeenth stage air cools the N1 and N2 turbine discs and the N2 turbine nozzle guide vanes. Combustion section cooling is accomplished by passing some of the primary air from the N2 compressor around the burner cans and mixing it with the hot gases inside the cans.

The relatively cool forward zone of the engine pod, containing the fuel and oil system components, is designated fire Zone 1. It is separated from the aft section, fire Zone 2, by a firewall. Zone 1 is cooled and ventilated by ram air. Zone 2 has no positive airflow. A flush scoop at the lower inboard cowl provides a higher air pressure in Zone 2 than in Zone 1 to prevent air leakage from Zone 1 to Zone 2. Each engine stub fillet (strut fairing) is similarly divided into Zones 1 and 2 by a firewall and a third firewall separates the stub from the engine pod. Each stub zone has cooling ram airflow in flight. Stub Zone 2 also uses a jet pump, operated by 5th stage bleed air, to induce cooling airflow on the ground.

(cont'd.)

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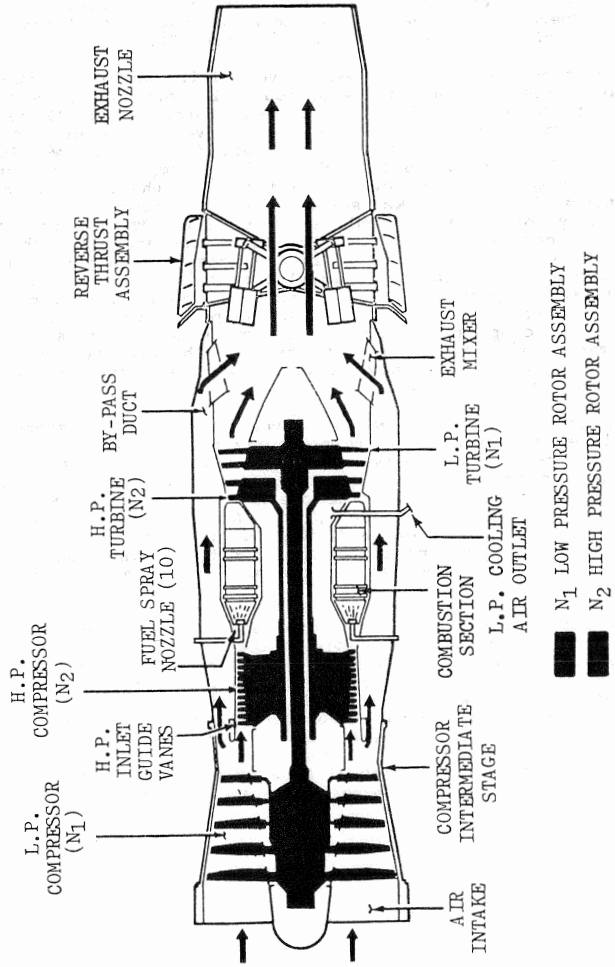
POWERPLANT SYSTEM DESCRIPTION

GENERAL DESCRIPTION (cont'd.)

Engine accessories are driven by two external gearboxes mounted on the bottom of the engine. The left-hand (LH) gearbox is driven by the N1 compressor shaft and the right-hand (RH) gearbox by the N2 compressor shaft. The N1 tachometer generator and N1 speed governor are driven by the LH gearbox. The RH gearbox drives a constant speed drive starter, generator, hydraulic pump, oil pump assembly, centrifugal breather, low pressure fuel pump, high pressure fuel pump, N2 tachometer generator, fuel flow regulator, N2 governor and airflow control N2 input. The N1 compressor front bearing mounts its own oil pump assembly.



POWERPLANT SYSTEM DESCRIPTION

ENGINE CONTROL SYSTEM

Engine thrust control is accomplished by metering fuel to the burner cans to obtain a reference N2 selected by throttle position. The fuel flow regulator automatically adjusts fuel flow in relation to changing ambient conditions in order to maintain the selected N2, and provides automatic protection against compressor discharge pressure (P3) overboost and exhaust gas (T6) overtemperature by limiting fuel flow at the point where either limiting parameter is reached. The N1 speed governor limits fuel flow as necessary to prevent N1 overspeed and as a backup in case of an N2 speed control malfunction in the fuel flow regulator. The N1 speed governor begins to influence engine operation at approximately 102.5% N1.

A throttle and a start lever for each engine are mounted on the pedestal. A lever on the forward side of each throttle controls reverse thrust. Each start lever (HP fuel lever) is connected by cables to the high pressure fuel shutoff valve, providing positive fuel cutoff to stop the engine. It has two positions, OPEN and SHUT. Intermediate positions should not be used. In the SHUT position, in addition to mechanically shutting off fuel to the fuel manifolds for engine shutdown, a microswitch in the pedestal closes the solenoid-operated CSDS air start valve. The throttles are connected through cables to the fuel flow regulator to provide selection of N2 speeds from idle to maximum allowable N2.

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POWERPLANT SYSTEM DESCRIPTION

ENGINE FUEL SYSTEM

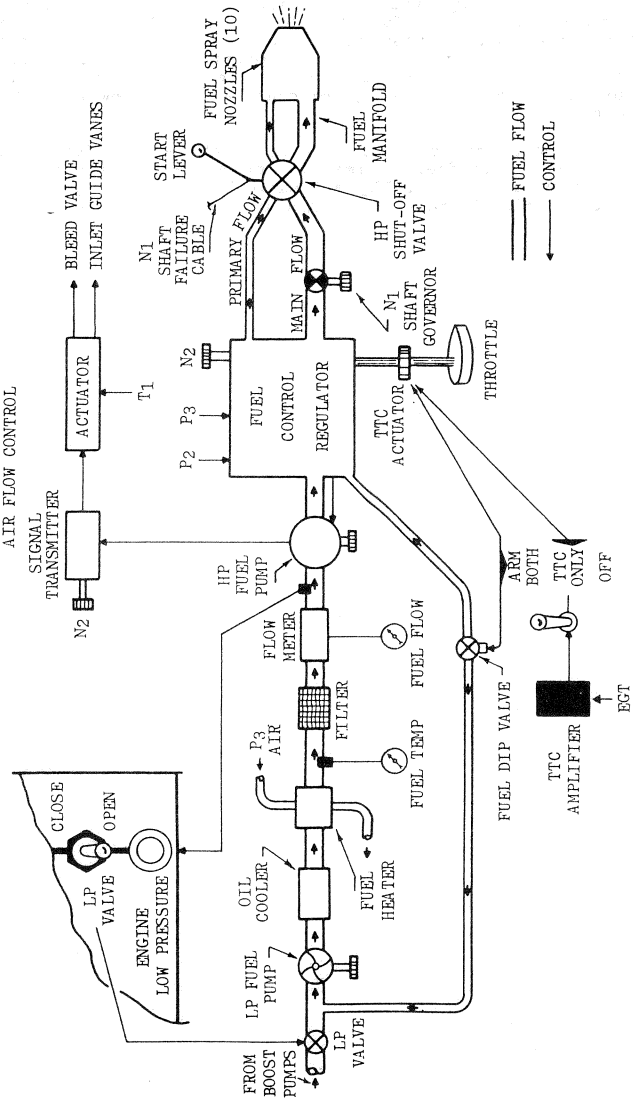
General Description

Fuel is supplied from the aircraft fuel system to an engine-driven high pressure fuel pump via an engine-driven low pressure fuel pump, fuel-cooled oil cooler, fuel heater filter, and flowmeter. Fuel from the high pressure pump is then supplied, via a fuel flow regulator and a high pressure shutoff valve, through parallel (primary and main) fuel manifolds to the combustion spray nozzles. High pressure fuel pump output is controlled by a hydromechanical fuel flow regulator and the N1 speed governor.

The fuel-cooled oil cooler, in which heat is transferred from the warm engine oil to the fuel, normally provides sufficient fuel heating. In low temperatures, the fully automatic fuel heater operates, using 17th stage bleed air, to maintain heater outlet temperature above +5°C.

POWERPLANT SYSTEM DESCRIPTION

ENGINE FUEL SYSTEM SCHEMATIC



POWERPLANT SYSTEM DESCRIPTION

AIRFLOW CONTROL

Compressor

The N2 compressor has variable angle inlet guide vanes (IGV's) and a 12th stage air bleed valve to insure stable airflow at low engine speeds and prevent compressor surges during acceleration and deceleration. These devices are powered hydraulically by engine fuel pressure. They are automatically controlled by an airflow control regulator in response to inlet and outlet pressures (P2 and P3) of the high pressure compressor, ambient temperature (T1) and N2. Generally at low N2, the IGV's are fully closed and the bleed valve is fully open to atmosphere. At high N2, the IGV's are fully open and the bleed valve is fully closed.

Engine Air Bleeds

Air is extracted from the engine compressors for use in the following airplane systems:

5th Stage -- Bleed Air Precooler
Zone 2 Stub Cooling Jet Pump

17th Stage - Air Conditioning and Pressurization
Engine Anti-Ice
Wing and Tail Anti-Ice
Constant Speed Drive Starter
Generator Ground Cooling Jet Pump
Thrust Reverser
Fuel Heater
Toilet Flushing
Hydraulic Tank Pressurization
Water Tank Pressurization

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POWERPLANT SYSTEM DESCRIPTION

TOP TEMPERATURE CONTROL (TTC)

To prevent exhaust gas temperature from exceeding limits, a top temperature control (TTC) system provides automatic limiting of fuel flow in response to amplified signals from the same thermocouples used for the EGT indicating system. An amplifier for each engine is in the aft stair area near the engine struts. A small electric motor slowly closes the throttle shaft at the fuel flow regulator, although the cockpit throttle lever does not move. The maximum trim correction is equivalent to about 17% of P7 or 3.6% of N2.

As a backup to TTC, a fuel dip system controlled by the same amplifier, is provided to reduce fuel flow should the rise in EGT exceed the authority of the TTC system. This could occur in the case of a power-on stall. A solenoid fuel dip valve opens to allow approximately 50% of the remaining fuel flow to return to the inlet of the low pressure pump. The valve then remains open for 5 seconds after EGT has fallen below the point at which the valve opened.

Operation of the TTC feature may be seen as a very slight reduction in engine power with the EGT remaining at its limit. Operation of the fuel dip feature is characterized by a sudden large reduction in power.

The TTC and fuel dip systems are controlled by a 3-position switch for each engine on the control pedestal. In the ARM BOTH position, both TTC and fuel dip are operative. TTC ONLY position is used for takeoff, landing, and engine starts. OFF position de-energizes both features.

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POWERPLANT SYSTEM DESCRIPTION

N1 (LP) SHAFT FAILURE SYSTEM

In the event of N1 shaft failure, turbine speed will exceed compressor speed causing a mechanical device on the N1 shaft to actuate, pulling a cable to shut off the HP fuel valve. The valve is then locked closed independent of start lever position and cannot be reopened from the cockpit. Thus, the engine is shut down automatically and cannot be restarted.

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POWERPLANT SYSTEM DESCRIPTION

IGNITION SYSTEM

General Description

Ignition for engine starting or relight is provided by a single igniter plug in two of the combustion cans, one for high energy discharge and the other for low energy discharge. Each plug is energized by its own separate ignition unit, located in the engine strut area. The low energy system is powered from its respective No. 1 or No. 2 main AC bus. The high energy system is powered from the ESS DC bus. Four amber lights on the overhead panel, one for each ignition unit, provide an indication when its respective ignition unit is energized.

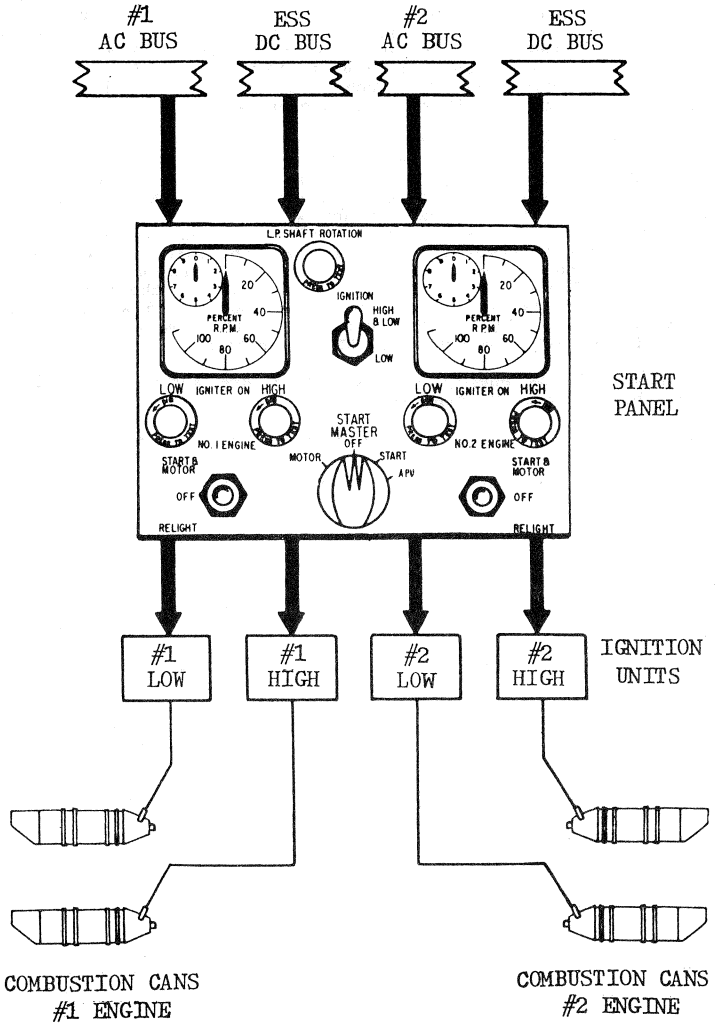
The ignition system is controlled by four switches on the overhead start panel. A single ignition switch for both engines permits selection of either HIGH & LOW energy or LOW energy alone. A single start master switch for both engines permits turning of the N2 compressor without ignition in the MOTOR position and with ignition for starting in the START position. A start selector switch for each engine activates the start or ignition systems as selected by the other two switches. In the RELIGHT position, either low or high and low ignition units are energized regardless of start master switch position. In the momentary START & MOTOR position, the N2 compressor will be motorized without ignition if the master switch is in MOTOR position or the complete start cycle will begin if the master switch is in START position.

The high and low energy ignition units are actuated automatically in flight by the stall warning system.

(cont'd.)

POWERPLANT SYSTEM DESCRIPTION

IGNITION SYSTEM SCHEMATIC



POWERPLANT SYSTEM DESCRIPTION

CONSTANT SPEED DRIVE STARTER (CSDS)

A pneumatically-operated constant speed drive start (CSDS), mounted on the N2 gearbox, provides for air powered turning of the N2 compressor during engine start and, after start, provides a constant speed drive for the engine-driven AC generator. The CSDS incorporates a differential gearbox and sprag clutch assembly, an air motor, and an air control valve assembly. Compressed air from the APU, an external air source or the 17th stage of the other engine passes through a pressure reducing valve and an air isolation valve located in the engine strut to the CSDS air control valve assembly. The control valve assembly includes a solenoid-operated start valve, actuated through the START and MOTOR position of the start selector switch. It controls the air supply to the air motor for starting.

The air control valve, positioned by a hydraulic governor utilizing CSDS oil pressure, regulates air flow to or from the air motor during constant speed drive operation. The generator is driven through a differential gear arrangement in which air motor speed is added to, or subtracted from N2 speed, resulting in a generator speed corresponding to an output alternating current frequency of 400 CPS. At low engine speeds, bleed air drives the air motor, supplementing N2 speed. At high engine speeds, the air motor is driven backward, drawing in ambient air to subtract from N2 speed.

An integral CSDS oil system, with its own oil tank and oil pump, lubricates gearing and provides oil pressure to operate the air control valve. Oil pressure is monitored by an amber CSD fail light on the overhead panel.

The CSDS drive shaft can be disconnected from the N2 gearbox by a pneumatic device operated by a disconnect solenoid. The solenoid is energized by a disconnect switch on the overhead panel. In case of generator overspeed, CSDS disconnects and air control valve closes automatically.

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POWERPLANT SYSTEM DESCRIPTION

START SYSTEM

General Description

The CSDS converts compressed air to torque which, transmitted through the N2 gearbox, accelerates the N2 rotor to establish airflow suitable for light-off. Fuel is sprayed into the combustion cans and is ignited by the igniter plugs in two of the cans. Flame propagates through the other cans and becomes self-sustaining. The ignition system is automatically cut off when the respective generator is reset.

Compressed air for starting passes through the pressure reducing valve (PRV), the air isolation valve and the CSDS air control valve enroute to the CSDS air motor for start. A check valve prevents air from entering the 17th stage of the engine being started.

Starting Sequence

A description of events in the normal starting sequence is as follows:

- Ignition Switch - HIGH & LOW. Arms both ignition units.
- Start Master Switch - START. Arms start system.
- Start Selector Switch - START & MOTOR. Locks out start system of other engine, opens PRV, closes temperature control valve, opens CSDS solenoid start valve, energizes ignition units, and arms N1 shaft rotation light. A holding relay allows the start selector switch to be released.
- LP Shaft Rotation Light - ILLUMINATED. Airflow through the compressor section turns the N1 compressor, illuminating the LP shaft rotation light.
- Start Lever - OPEN. Opens HP fuel valve. Fuel sprays into the combustion chamber. Light-off is indicated by EGT rise.
- As N2 overtakes air motor speed, sprag clutch disengages and CSDS assumes constant speed drive operation.
- After the engine stabilizes at idle and the generator is reset:
  - Ignition units are de-energized.
  - LP shaft rotation light extinguishes.
  - PRV reverts to pressure reducing function.
  - Temperature control valve reverts to normal operation.

Aborted Start

Events in an aborted start are as follows:

- Start Lever - SHUT. Mechanically closes HP fuel valve and electrically closes solenoid start valve.
- Start Master Switch - OFF. De-energizes ignition units.
- Air Conditioning Master Valve - APU. Closes PRV as a backup to solenoid start valve to prevent air from reaching the CSDS.

(cont'd.)

POWERPLANT SYSTEM DESCRIPTION

START SYSTEM (cont'd.)

Battery Start

When external power is not available and the APU generator or the APU itself is inoperative, the engines may be started using the battery as the only electrical source. Battery power will energize the high energy ignition system.

The EGT and tachometers are self-energizing. The fuel boost pumps will be inoperative but are not normally necessary for engine start. Other inoperative systems are:

- low energy ignition,

- top temperature control,

- fuel flowmeters,

- foot brake pressure, and

- No. 2 main duct pressure gauge.

The air crossfeed valve will be de-energized and spring-loaded to the closed position. Therefore, using an external air source, the No. 2 engine must be started first. Using the APU as an air source, the No. 1 engine must be started first. If brake accumulator pressure is low, it can be recharged by holding the DC pump switch momentarily in the BRAKE ACC position.

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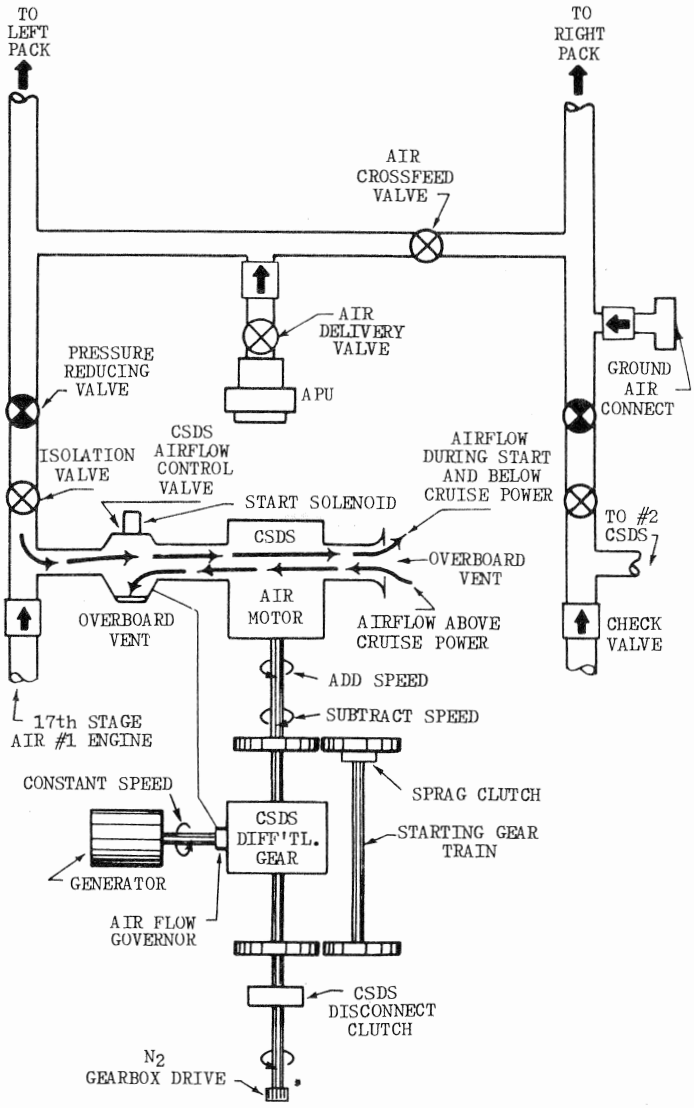
POWERPLANT SYSTEM DESCRIPTION

START SYSTEM SCHEMATIC



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POWERPLANT SYSTEM DESCRIPTION

ENGINE OIL SYSTEM

General Description

The engine oil system circulates oil to lubricate and cool gears, bearings and splines throughout the engine. The complete system is housed within the engine structure. An oil tank is mounted on the left-hand side of the engine. Oil is circulated by a pump assembly consisting of one pressure pump and five scavenge pumps mounted on the N2 gearbox. The front bearing of the N1 compressor has its own metering and scavenge pump driven directly by the N1 compressor. A pressure relief is incorporated in the oil filter. Oil is cooled by engine fuel flow through the oil cooler. Both the oil cooler and filter have bypass valves in case of clogging. Oil pressure is measured electrically at the filter outlet for both the oil pressure gauge and an oil low pressure warning light. Oil temperature is taken at the oil cooler outlet. A centrifugal breather, mounted on the N2 gearbox, vents the N2 gearbox and oil tank to atmosphere.

Total oil system capacity is 28.8 pints. Tank capacity is 14.4 pints of which 10.8 are usable. The tank can be pressure filled or gravity filled. A sight gauge is provided on the side of the tank to check oil level.

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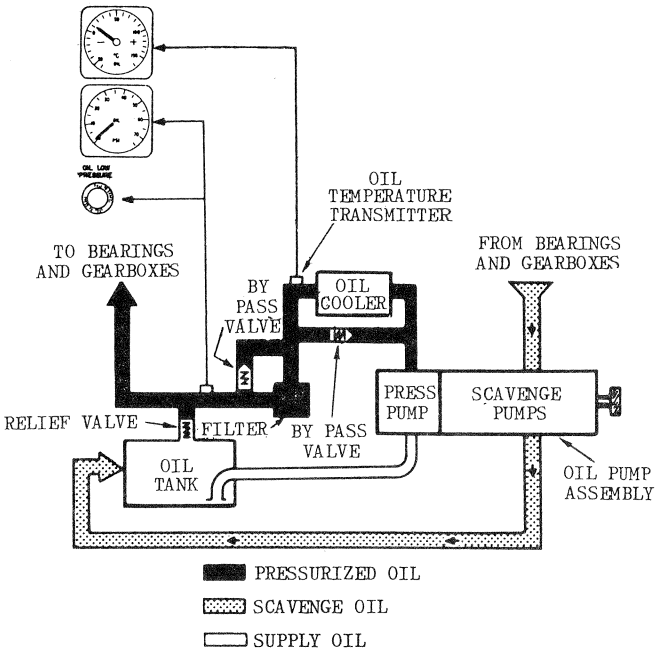
POWERPLANT SYSTEM DESCRIPTION

ENGINE OIL SYSTEM SCHEMATIC



POWERPLANT SYSTEM DESCRIPTION

REVERSE THRUST SYSTEM

A clamshell door-type thrust reverser unit is part of the exhaust system of each engine. Reverse thrust is achieved by blocking the rearward exhaust gas flow with clamshell doors which deflect the gases through cascade vanes above and below the reverser unit. When reverse thrust is required, the throttle levers are moved to the fully closed (idle) position and the reverse thrust levers are pulled upwards and rearwards. This locks the throttle levers in the closed position and directs 17th stage engine bleed air to unlock and then to close the two reverser doors.

Initial movement of the reverse thrust levers is restricted mechanically to 20% engine power until the clamshells are in full reverse (closed) position. An amber reverser unlocked light on the center instrument panel for each engine illuminates when the reverser is unlocked from the forward thrust position. A detent near the full aft stop provides an approximate physical indication of normal reversing power. Further aft movement of the reverser levers will select maximum reversing power. In coming out of reverse, the reverse thrust levers are pushed forward and then down. It is not possible to move the normal throttle levers forward of idle until the clamshell doors are completely open and locked as indicated by the reverser unlocked light extinguishing. However, if the reverse throttle levers are pushed all the way forward and down immediately from a high power setting in reverse thrust, the clamshells may open before the engine has time to decelerate to idle, resulting in momentary undesired forward thrust.

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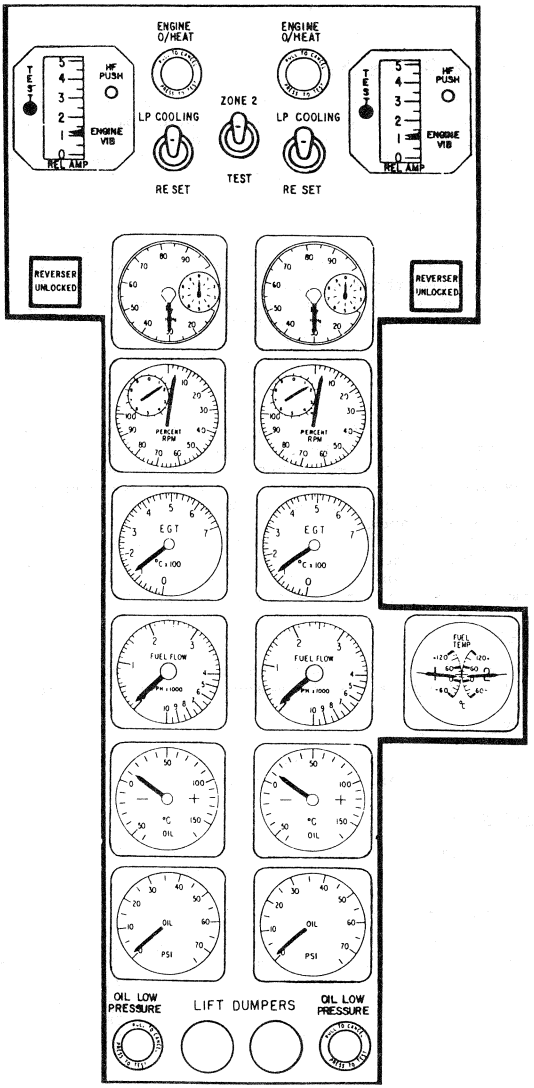
POWERPLANT SYSTEM DESCRIPTION

CONTROLS AND INDICATORS

All engine instruments are mounted on the center instrument panel, except the N1 tachometers which are on the overhead panel.

Engine Instrument Panel



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POWERPLANT SYSTEM DESCRIPTION

CONTROLS AND INDICATORS (cont'd.)

Engine Exhaust Pressure (P7)

Engine thrust, in terms of exhaust gas absolute pressure in inches of mercury, is indicated by a P7 indicator for each engine. Nine forward facing pressure sensing probes are circumferentially arranged in the exhaust section. Tubes carry ram pressure from the probes to the instrument where it is compared with static pressure from a port on the lower left side of the aircraft under the cockpit. Operation is fully pneumatic and self-powered.

Engine Tachometers (N1 and N2)

Engine low pressure compressor speed (N1) and high pressure compressor speed (N2) are presented by tachometer indicators for each engine. Each system generates its own electrical power and signal source. The N1 tachometer generator is mounted on the left-hand gearbox. The N2 tachometer generator is mounted on the right-hand gearbox.

Exhaust Gas Temperature (T6)

An exhaust gas temperature indicator for each engine calibrated in °C presents the temperature in the exhaust just downstream of the turbines. Ten (10) self-powered thermocouples are mounted circumferentially in the exhaust section and provide signals to the indicator independent of the aircraft electrical system. A correction placard on each EGT indicator provides the indicated value that should be set to produce the desired value for cruise and climb power, i.e., "465 set 468" or "480 set 485".

Fuel Flow

Fuel consumption in pounds per hour (PPH) is presented on a fuel flowmeter for each engine. The indicator is actuated electrically from a fuel flow transmitter located schematically between the fuel filter and the high pressure pump. The fuel flowmeter may indicate fuel flow (as much as 1,600 PPH) momentarily when the boost pumps are turned on. This is caused by a small amount of air in the fuel line, downstream of the fuel flow transmitter, which is compressed when fuel in the line is pressurized. This should not be considered abnormal provided the indication begins to drop off after about 5 seconds. Neither accuracy of the fuel flowmeter nor engine performance will be affected in any way.

Fuel Temperature

Fuel temperature (in °C) for both engines is read on one dual indicating instrument. Fuel temperature is measured at the fuel heater outlet.

Engine Oil Temperature

An indicator for each engine presents engine oil temperature (in °C), as measured at the engine oil cooler outlet.

Engine Oil Pressure

An indicator for each engine displays engine oil pressure in pounds per square inch (PSI) as measured by a transmitter at the oil filter outlet.

Engine Vibration Indicator

An indicator for each engine shows a relative amplitude to the vibration pick-up signal and is scaled from 1 to 5 units. A button on the instrument labeled HF PUSH causes the lower vibration frequencies to be filtered out permitting a check on the high speed rotor vibrations. A test button on the indicator is depressed to check the system. Simultaneously depressing the HF push button tests the high frequency feature.

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AUXILIARY POWER UNIT SYSTEM DESCRIPTION

GENERAL DESCRIPTION

A self-contained auxiliary power unit (APU) is housed in a fireproof nacelle in the tailcone of the airplane. The APU is a small gas turbine with a two-stage centrifugal compressor coupled to a single-stage turbine. It is governed to constant speed operation and can be used to furnish pneumatic and/or electrical power both on the ground and in flight.

The APU drives a 40 KVA generator and its compressor is bled to provide pneumatic power for engine start, airframe anti-icing, and air conditioning. The bleed air (air delivery) valve is thermostatically controlled to give preference to producing electrical power over bleed air when there is a high electrical and/or pneumatic demand.

A self-contained positive pressure, dry sump oil system provides pressurized and splash lubrication.

Fuel is supplied from the No. 1 aircraft tank, through an electrically operated low pressure fuel valve and boost pump, to the fuel control. The fuel control regulates fuel flow to maintain a constant speed (about 100%) and to prevent the EGT from exceeding 710°C.

Electrical power for starting the APU is supplied by the ESS DC bus and the battery bus.

Air for cooling the generator, oil cooler and exhaust unit, and air for general ventilation of the APU by is obtained via inlet holes located forward of the fireproof bulkhead and in the tailcone.

When applying electrical load, the APU generator will pick up electrical load automatically provided APU generator control switch is in NORMAL position and electrical system priority circuits are calling for APU generator.

Before applying pneumatic load, allow APU EGT to stabilize. Apply APU pneumatic load gradually. Whenever possible, position master valve selectors to APU individually, pausing about 20 to 30 seconds before positioning the second master valve to APU. This gradual pneumatic loading procedure will curtail the APU EGT overshoots that sometimes occur when both master valves are positioned to APU simultaneously, and it will usually permit a marginal APU to carry both air conditioning packs. Opening the APU air delivery valve permits the APU to supply the left side of airplane (left pack and No. 1 CSDS). To supply the right side of the airplane from APU, open air crossfeed valve.

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AUXILIARY POWER UNIT SYSTEM DESCRIPTION

APU FIRE WARNING SYSTEM

Testing of the APU fire warning system by the flight crew is required only at flight originations and before starting APU in flight. If APU is already running, i.e., Maintenance has already started APU test system during accomplishment of BEFORE START checklist. Test system as follows:

APU Fire Switch - MANUAL. Fire warning system will not test if switch is left in AUTO.

CAUTION: Do not move fire auto/manual switch to AUTO while holding the APU fire handle test switch as this will lock in the automatic protection circuit and will discharge the APU fire extinguisher.

APU Fire Handle Switch - TEST. Check fire handle light illuminates and fire warning bell sounds, then release switch.

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AUXILIARY POWER UNIT SYSTEM DESCRIPTION

APU IN-FLIGHT START

If starting APU in flight, see APU INFLIGHT RELIGHT ENVELOPE in this section.

NOTE: Avoid tailwind starts, if possible.

Battery Switch - ON.

Engine Start Master Switch - APU.

APU Air Delivery Valve - CLOSE.

APU Fire Warning - TEST.

APU Control Switch - ON. Check fuel valve annunciator shows OPEN and start annunciator shows "black."

Push-to-Start Button - DEPRESS. Hold momentarily, then release. Check that start annunciator shows START.

APU EGT - MONITOR. Check time required to light-off. If no EGT rise within 15 seconds, move APU control switch to OFF and allow 2 minutes for APU to drain before attempting another start.

NOTE: During start, annunciator will move from START to "black" when starter holding circuit cuts out, then annunciator will move to RUN when APU reaches normal operating speed.

Maximum allowable time from light-off to no-load speed is 30 seconds. (RUN shows on annunciator.)

Engine Start Master Switch - OFF.

APU Fire Switch - AS REQUIRED. Place switch to AUTO only when cockpit is to be left unattended; otherwise, leave switch in MANUAL.

(cont'd.)

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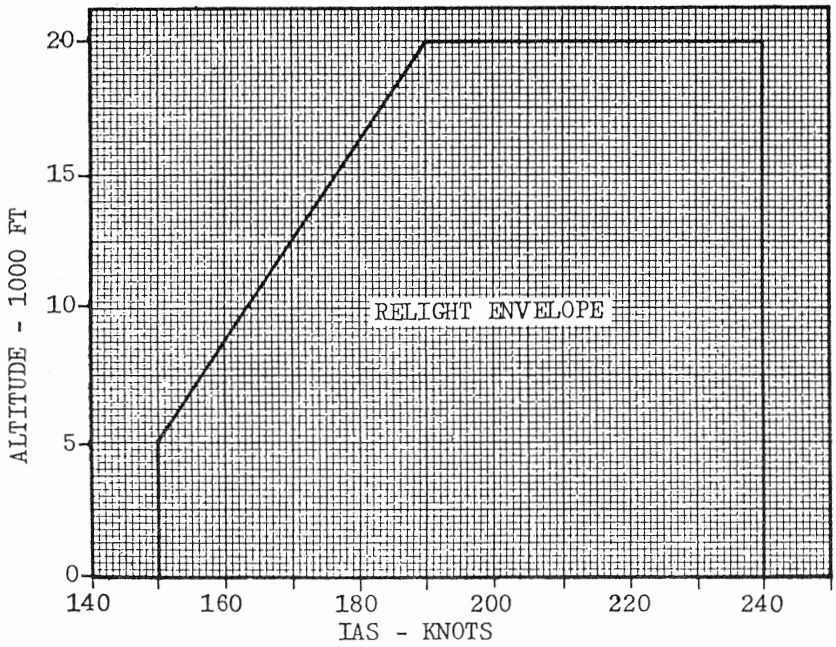
AUXILIARY POWER UNIT SYSTEM DESCRIPTION

APU IN-FLIGHT START (cont'd.)

APU Inflight Relight Envelope

Successful relights using batteries only have been demonstrated within this relight envelope. If normal generator power is available, first start attempt may be made at any airspeed or altitude. If only battery power is available, or if second start attempt, attempt start only within this envelope.



AUXILIARY POWER UNIT SYSTEM DESCRIPTION

APU SHUTDOWN

Normal shutdown is accomplished as follows. This will close both fuel valves and stop the fuel boost pump.

APU Air Delivery Valve - CLOSE.

APU Generator Control Switch - TRIP, if generator providing power. Allow APU EGT to stabilize in idle range (280°C - 340°C), which normally takes about 30 seconds.

APU Control Switch - OFF. Check that fuel valve annunciator shows CLOSED and APU EGT decays normally.

The unit can also be shut down by operating the:

- Cockpit APU Fire Handle.
- Overspeed Test Switch at the External Panel.
- Fire Switch at the External Panel.

The APU will automatically shut down when:

- Cockpit fire switch is in AUTO position and an APU fire warning occurs.
- An overspeed occurs (110% RPM).
- APU oil pressure drops below 3 PSI.

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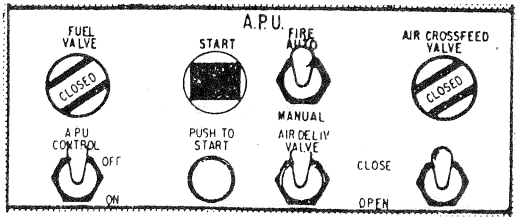
AUXILIARY POWER UNIT SYSTEM DESCRIPTION

CONTROLS AND INDICATORS

APU COCKPIT CONTROL PANEL



(Overhead Instrument Panel)

APU Control Switch

This switch when positioned to ON causes the following actions to occur:

- APU low pressure fuel valve opens.
- Starter circuit is armed.
- Fuel valve annunciator moves from CLOSED to OPEN when low pressure fuel valve fully opens.

Engine Start Master Switch

This switch is positioned to APU prior to starting the APU and returned to OFF after the APU has been started.

APU Start Switch and Start Annunciator

This switch, when depressed, completes a holding circuit to start the APU. The annunciator has three positions: "Blank", START, and RUN. When APU control switch is ON and start switch is depressed, the following actions occur:

- Annunciator indicates start.
- Starter motor engages and cranks.
- Fuel boost pump is energized.
- When oil pressure rises, high pressure fuel solenoid valve opens and ignition is energized.
- Light-off occurs.
- As RPM rises starter de-energizes, annunciator shows "blank."
- Near operating RPM ignition de-energizes, annunciator indicates RUN, and interlock circuit permits operation of the air delivery (bleed air control) valve.

(cont'd.)

Supplied by Jeppesen Sanderson

AUXILIARY POWER UNIT SYSTEM DESCRIPTION

CONTROLS AND INDICATORS

APU COCKPIT CONTROL PANEL
(cont'd.)

Air Delivery Valve Switch

This two-position switch controls operations of the APU air delivery circuit. Interlocks prevent valve from opening before 85% RPM (RUN showing on annunciator). At an APU EGT of 677°C, the bleed air load control thermostat starts to close the bleed air control valve to reduce the amount of air flow, thus containing EGT. High electrical loads increase EGT which results in a decrease in the amount of bleed air available. If possible, electrical loads should be reduced when pneumatic requirements are high.

Air Crossfeed Valve Switch and Annunciator

This switch controls the crossfeed valve between the No. 1 and No. 2 pneumatic systems. The annunciator reads OPEN or CLOSE as a function of valve position.

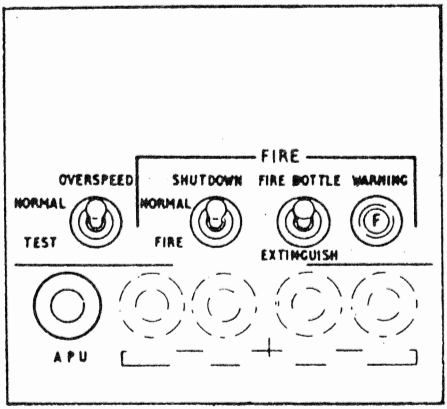
APU EGT Indicator

This self-energized indicator is located on the First Officer's console. It is calibrated in °C. A red radial line on the indicator face indicates the absolute temperature limit.

AUXILIARY POWER UNIT SYSTEM DESCRIPTION

CONTROLS AND INDICATORS

APU EXTERNAL CONTROL PANEL



(Aft Lower Right Side of Fuselage)

Overspeed Test Switch

When positioned to TEST, this switch completes a circuit to simulate APU overspeed and causes the APU to shut down automatically.

Shutdown Switch

When positioned to FIRE, this switch shuts down the APU and arms the fire extinguishing system.

Fire Bottle Switch

When positioned to EXTINGUISH, this switch discharges the APU fire bottle provided fire switch is in the FIRE position.

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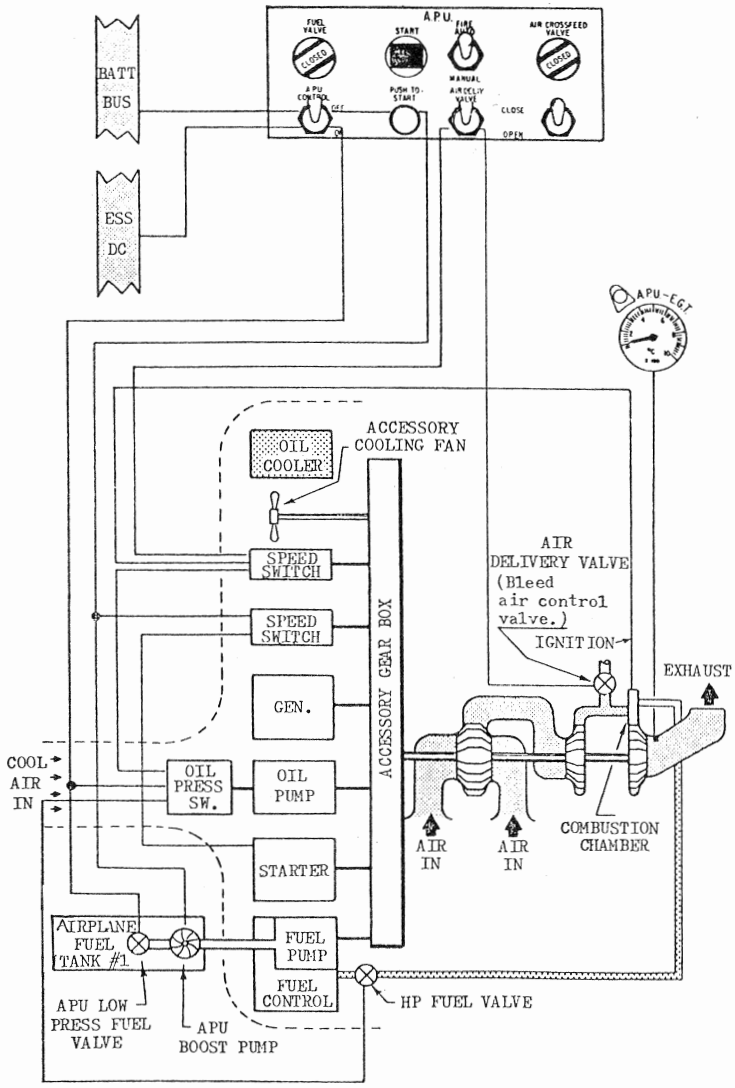
AUXILIARY POWER UNIT SYSTEM DESCRIPTION

SCHEMATIC



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BAC 1-11

FLIGHT INSTRUCTION/PROFICIENCY CHECK OUTLINE

USE OF POWER DURING TRAINING

In all pull-up procedures (emergency go-around, missed approach, engine failure at or above V1, etc.) the pilot flying the aircraft should call for the appropriate power setting while advancing the throttles. The check pilot/instructor will, in most cases in the actual aircraft, restrict power to a lower limit to simulate a higher gross weight aircraft consistent with approved training practices.

In the simulator, as in line operation, maximum power is defined as at least takeoff power as computed for the temperature and elevation. Firewall power is defined as advancing the throttles to the mechanical stops.

ENGINE EMERGENCY OVERBOOST CAPABILITY

Multiple emergencies, adverse weather such as wind shear and other possible circumstances could arise where the use of thrust above normal established limits (FIREWALL POWER) could prevent a major accident.

Engines on the BAC 1-11 have thrust available beyond these established limits (red line) that should be used as a last resort when all other recovery actions have been ineffective.

Maximum thrust available (FIREWALL POWER) to avoid imminent ground contact could be used for the time required to recover from the situation. Normal engine life may be shortened. This will depend on the ambient conditions and the amount and duration of the overboost.

Maximum thrust available up to the throttle mechanical limits (FIREWALL POWER) is also used in recovery from approach to stall.

Following an overboost, the engine parameters which exceeded the limits and the duration of the overboost should be recorded for Maintenance action as required by the Maintenance Manuals.

This information should be a crew briefing item and consideration should be given to incorporation in simulator training, but should not be used in actual inflight training.

GENERAL

The following material is a guide to the procedures, maneuvers, and methods involved in the various types of flight training and flight checks necessary to maintain pilots at the highest proficiency level. All types of flight instruction and checking are covered in general where necessary; specific maneuvers and standards are indicated for particular types of flights, as dictated either by Company policy or by Federal Aviation Regulations.

Different types of training/check flights include: Prehiring check, Initial/Transition training, Upgrade training, Pilot-in-command proficiency checks, Second-in-command proficiency checks, Recurrent training, ATPC and type rating checks.

The description of procedures and maneuvers and recommended techniques in this training section serve equally for line operation and complement the material contained in the Normal Operating, Abnormal, and Emergency sections of this manual. Pilots should be completely familiar with and operate in accordance with material in each section.

Conditions beyond the control of the flight crew may preclude following an illustrated maneuver exactly. The maneuvers are not intended to replace good judgment and logic.

The maneuvers will be accomplished as illustrated during training. However, due to conflicting traffic at training airports, ATC traffic separation requirements, and radar vector advisories, modifications may be necessary.

Supplied by Jeppesen Sanderson

BRIEFING/EQUIPMENT EXAMINATION (Oral or Written)

The briefing includes a preview of maneuvers and procedures to be performed, and a review of the aircraft and its systems. It includes pertinent information relating to aircraft and powerplant performance and systems, normal and abnormal operating procedures, and emergency procedures, as well as appropriate provisions of the FAA Approved Flight Manual. The review is oral for all training/checking except for proficiency checks and recurrent flight training. In this case, it may be oral or written.

A post-flight debriefing should be conducted following the flight, which includes a critique of trainee performance and progress and a preview of the next flight with direction for preparation. The debriefing can be utilized to test the trainee's knowledge of procedures, maneuvers and systems as well as the briefing.

JUDGMENT

Throughout the maneuvers, the trainee must demonstrate judgment commensurate with a high level of safety. In determining whether such judgment has been demonstrated, consideration will be given to adherence to approved procedures and action in situations requiring a decision where there is no prescribed or recommended practice.

PREFLIGHT INSPECTION AND CHECKS

A visual inspection of the exterior and interior as appropriate shall show that the aircraft is in a satisfactory condition, and that minimum equipment requirements are met, both normal and emergency. The manner in which the inspection is conducted, with specific items and general condition being checked, is considered as part of the overall flight training/checking period. The trainee must briefly explain each item inspected.

Proper use and familiarity with the **CHALLENGE** and **RESPONSE** type method of cockpit check procedures is considered an important part of the flight. All items (including radio and electronic equipment and selection of proper navigation and communications radio facilities) should be checked and/or operated, engines started, etc., by the recommended instructions as outlined in Chapter 3 - Normal Operating Procedures of this manual. All pre-takeoff checks, including powerplant checks, should be performed as outlined in Chapter 3 - Normal Operating Procedures.

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TAXIING

The pilot flying will normally start the engines, and, after the Captain has received and acknowledged the salute, s/he should advance the thrust of both engines sufficiently to start the aircraft moving, then immediately retard to idle for the initial turn away from the ramp area. Company policy states that the Captain should be at the nosewheel steering control when departing from and arriving at the gate parking area. It should be made clear by the Captain or instructor when control is transferred.

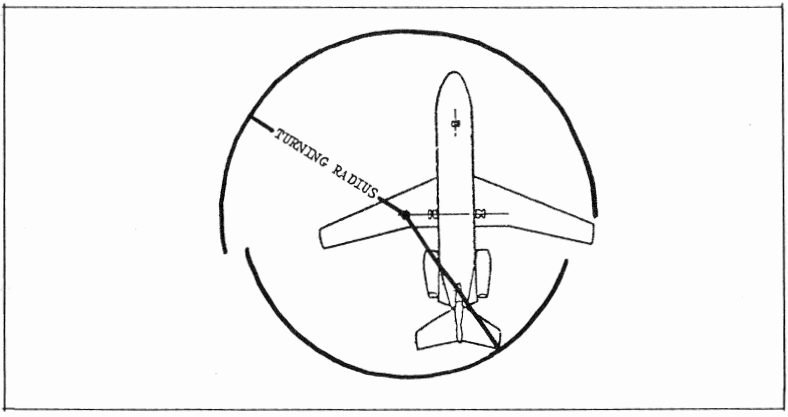
Clearance should be received from ramp personnel and/or control tower before taxiing. The thrust required to start taxiing is generally much more than is needed for continuous ground movement of the airplane and depends on the airplane gross weight and ramp or taxiway conditions. The thrust should be sufficiently high to start rolling; thereafter, idle thrust or slightly higher is sufficient to maintain normal taxi speeds. Use caution in the initial application of thrust on the fan engine. Due to the low thrust acceleration from idle, proper use is necessary to prevent excessive jet blast in ramp areas.

The use of **high thrust** on the engine on the outboard side of the turn is not recommended. Care must be exercised in the use of thrust in a turn if the aircraft is allowed to slow or stop with the nose wheel turned 45° or more. The fan engine has great thrust capabilities, and with slow acceleration from the idle position, improper use of the throttles can cause excessive acceleration of thrust that will impose undue side loads on the cocked nose wheel.

Taxi in the center of taxiways, using 18° wing flap. This flap setting reduces the possibility of ingesting foreign particles into the engines. Maintaining taxiway center prevents the possibility of running the main gear off the taxiway or of colliding with exposed taxi lights when trying to "cut a corner". Keep in mind that the nose gear is some 8 feet aft of the pilot's seat position; therefore, a pilot should project himself/herself or the nose of the aircraft slightly past the centerline of the intended turn prior to turning the aircraft.

The instructor may provide the runway information and air traffic control clearances. While the aircraft is being taxied to the runway, the Before Takeoff checklist should be completed using the **Challenge and Response** method. Appropriate "V" speeds, engine power (rated P7) settings, and stabilizer trim settings should be computed by the trainee, as practicable.

Turning Radius



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TAKEOFFS

General

Takeoffs during training may be broken down into normal, engine-out, crosswind, day or night, rejected, instrument or any combination. The engine-out configuration may be established before reaching V1/Vr speed or after lift-off.

Normal Takeoffs -- Two Engines

After completion of the BEFORE TAKEOFF checklist, align the aircraft with the centerline of the runway. Smoothly apply takeoff thrust to both engines. The responsibility for setting power shall be left to the trainee actually making the takeoff with the instructor monitoring power and instruments.

The pilot not manipulating the controls should perform the following duties during takeoff:

- Guard the yoke, back up the throttles (with fingertips from the side, high on the throttle shaft), check overhead panel LP RPM, engine anti-ice pressure, lights, etc., monitor instruments, call out any malfunction or abnormal reading observed.

- During crosswind conditions, aileron input should only be that necessary to maintain wings level. Observe a 15° maximum yoke travel to prevent spoiler deployment.

- Call out 80 knots and 100 knots airspeed, cross-checking both indicators simultaneously. Relinquish aileron and elevator controls to pilot flying.

  Call V1/Vr speeds as they are attained.

The pilot flying should:

- Use nosewheel steering for line-up and during the initial low speed portion of the takeoff roll. When the pilot not flying calls 80 knots/100 knots, transfer hand from nosewheel steering to yoke. The use of nosewheel steering at speeds above 80 knots is not desirable as it affords very little directional control and can result in severe nosewheel tire scuffing.

- When V1/Vr is called, a smooth rotation into a positive angle of attack (approximately 9-12°, initially, then maximum 15°) should be made, which will result in attaining V2 speed at 35 feet. This attitude will produce the desired performance and speed. Maintain that attitude (not to exceed 15°) and the airspeed will quickly accelerate beyond V2. This is normal and attitude should not be increased beyond 15° in an attempt to maintain V2 speed.

- As soon as definitely airborne with a positive rate of climb, the pilot flying commands gear retraction. Runway or noise abatement heading should be maintained initially. Climb should be made at V2 + 10 knots or higher as necessary to limit deck angle to 15°. At 1,000 feet above field level, raise flaps to 8° (or 0° if V2 + 20), reduce to climb power.

- Pitch attitude can be reduced by 5-6° (or not more than one-half of the pitch attitude required to hold V2 + 10) if necessary to accelerate to 0° flap speed. Continue climbing during flap retraction and power reduction, accelerate to zero flap maneuver speed for climb to 3,000 feet above field level.

Supplied by Jeppesen Sanderson

TAKEOFFS (cont'd.)

Normal Takeoffs -- Two Engines (cont'd.)

- Accelerate to 250 knots, maintaining an approximate 1,000 FPM climb rate during acceleration. The pilot flying should command the pilot not flying to complete the AFTER TAKEOFF checklist.

NOTE: The noise abatement climb profile above is used for all takeoffs except at New York area and Washington National airports. Refer to Chapter 3, Section 3-60 Noise Abatement profiles for procedures at those airports.

NOTE: If takeoff was made with 8° flaps, accelerate to V2 for 8° plus 10 knots before retracting flaps at 1,000 feet.

NORMAL TAKEOFF

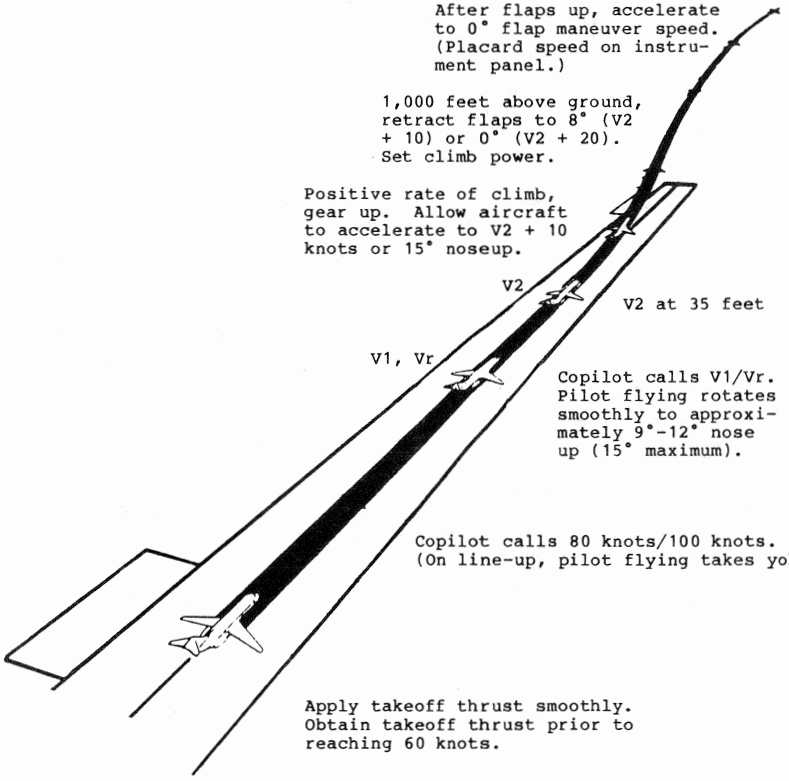
In Airport Traffic Area: 200 knots.
Below 10,000 feet: 250 knots maximum.
Enroute Climb: 280 knots/M.70
Turbulence Penetration
Above 10,000 feet: 250-270 knots.

AFTER TAKEOFF CHECKLIST

When out of 10,000 feet.

3,000 feet above ground, accelerate to 250 knots.

NOTE: If takeoff was made with 8° flaps, retract flaps at 1,000 feet at V2 for 8° + 10 knots.


After flaps up, accelerate to 0° flap maneuver speed. (Placard speed on instrument panel.)
1,000 feet above ground, retract flaps to 8° (V2 + 10) or 0° (V2 + 20). Set climb power.
Positive rate of climb, gear up. Allow aircraft to accelerate to V2 + 10 knots or 15° noseup.
V2
V2 at 35 feet
V1, Vr
Copilot calls V1/Vr. Pilot flying rotates smoothly to approximately 9°-12° nose up (15° maximum).
Copilot calls 80 knots/100 knots. (On line-up, pilot flying takes yoke.)
Apply takeoff thrust smoothly. Obtain takeoff thrust prior to reaching 60 knots.

TAKEOFFS (cont'd.)

Instrument Takeoff

Instrument conditions in the aircraft are simulated by use of a hood at or before reaching 100 feet above airport elevation. Insure a positive rate of climb prior to raising gear. For training, hood is placed after reaching Vmca, prior to V1 and check for low RVR values such as 600 RVR).

In both the simulator and the aircraft, emphasis is placed on maintaining runway heading as well as proper rotation rate and attitude.

Crosswind Takeoff

The crosswind takeoff characteristics of the BAC 1-11 are typical of most swept-wing transports, and the techniques required for this kind of takeoff are not much different than those used during the normal takeoff. The upwind wing will have a tendency to rise and aileron deflection must be applied in the direction of the crosswind to maintain wings level. This deflection will not materially affect the takeoff performance if input is not more than 15° of yoke travel. Further input would result in spoiler deployment, causing drag. Some forward yoke pressure should be applied (by the copilot after the pilot has released it), to insure positive nose wheel contact. (Avoid excessive "pinning" of nose gear). Rudder correction should begin at brake release with less reliance on nosewheel steering as speed increases. Aileron input should be decreased as speed increases. The primary objective of aileron input during crosswind takeoff (or landing roll-out) is to KEEP THE WINGS LEVEL.

Rejected Takeoff

If an engine failure/fire, simulated or actual, (or any situation such as takeoff warning horn, warning light, loss of power, high EGT, etc.) occurs prior to V1, the takeoff should be rejected immediately. The Captain makes all takeoff reject decisions. When alerted to the abnormal situation, the Captain should call "REJECT", immediately apply maximum wheel brakes while closing throttles, actuate spoilers, and engage maximum reverse thrust, unless conditions dictate otherwise. At the instant of engine failure, some yawing of the aircraft will occur toward the failed engine. Necessary rudder should be applied. Forward elevator pressure increases steering capability. Reduce reverse thrust at low speed to minimize foreign object ingestion and compressor stalling.

The control tower should be advised of intentions and the problem. It is also desirable to inform the passengers of the situation via the P.A. to relieve apprehension.

To emphasize the possible adverse consequences of an improperly performed RTO (miscalculation of actual remaining runway versus speed, complacency, etc.), realistic situations should be presented to all crewmembers during simulator training and checks. The RTO maneuver should be initiated in the simulator with a critical length runway (i.e., at a maximum gross takeoff weight for that runway considering ambient temperature), and at speeds just before V1. This training should enable all crews to gain adequate and realistic experience to perform a maximum effort RTO if the necessity should arise in actual line operation.

TAKEOFFS (cont'd.)

First Officer Rejected Takeoff

First Officers will be trained to execute the RTO maneuver in consideration of possible Captain incapacitation, his/her seat sliding aft, etc., during the takeoff. When the First Officer is given RTO's in the simulator, s/he will assume that one of this type situation has occurred. In the briefing, the First Officer should control the throttles throughout the entire RTO maneuver. (During actual line operation, when the First Officer is executing a takeoff and an RTO situation is encountered, the Captain will perform the RTO unless s/he is physically unable to do so.)

NOTE: Training will be accomplished on single engine reverse demonstrating asymmetric thrust effects. However, both engines should be reversed to take advantage of any remaining thrust in the failed engine and the open reverser panels. This would apply to single engine landings.

Engine Failure At or Above V1

When an engine failure occurs, the takeoff is normally refused when the failure is recognized prior to V1 and is normally continued when it is recognized after V1. At V1, the takeoff may either be continued or refused.

The pilot making the takeoff shall normally continue to control the airplane. If the First Officer is making the takeoff (and not relieved by the Captain), the Captain will accomplish the required IMMEDIATE ACTION items.

When an engine failure occurs after V1 on takeoff, the following climb speeds will be utilized to 500 feet AGL or obstacle clearance altitude, whichever is higher. However, when takeoff flight path is known to be free of obstacles, i.e., overwater or flat terrain, level-off altitude for flap retraction may be lower than 500 feet AGL if such action is deemed appropriate by the Captain. Normally, such selected altitude should not be less than 400 feet AGL.

- If engine failure occurs after V1 but not above V2, maintain V2.

- If engine failure occurs after V2, maintain speed attained at time of failure not to exceed V2 + 10 knots.

- If engine failure occurs at a speed greater than V2 + 10 knots, reduce to and maintain V2 + 10 knots.

Use the following speed/flap retraction schedule at the flap retraction level-off altitude, normally 500 feet AGL or obstacle clearance altitude, whichever is higher. A flap setting of 8° if the standard takeoff flap setting.

- For 8° flap takeoff, accelerate to V2 + 10 knots and retract flaps to 0°.

- For 18° flap takeoff, accelerate to V2 + 10 knots and retract flaps to 8°. Continue acceleration to V2 + 20 knots and retract flaps to 0°.

- For 3° flap takeoff, accelerate to V2 + 10 knots and retract flaps to 0°.

TAKEOFFS (cont'd.)

Engine Failure At or Above V1 (cont'd.)

Full power should be used to the flap retraction level-off altitude (normally 500 feet AGL or obstacle clearance altitude, whichever is higher). After flap retraction and acceleration to VFS or chart maneuver speed for 18° flaps ("V-RETURN" speed + 20 knots), if returning to land, establish climb attitude and reduce to METO power.

If an extended climb is required, when leaving 1,500 feet AGL or 1,000 feet above the obstacle clearance altitude, whichever is higher, and while increasing to enroute climb speed, set climb power.

If an extended climb is required, due to the inability to return for an immediate landing at departure airport, increase speed to obtain best single-engine enroute climb speed. Generally, this speed is equal to VFS plus 50 knots or as given in the following table.

GROSS WEIGHT (1,000 lbs.)	60	65	70	75	80	85	90
Single-Engine Climb Speed (Flaps 0°) (KIAS)	190	200	205	215	220	230	235

The takeoff engine failure profile included in this section depicts procedures applicable for either a return to departure point for a landing on single engine, or climb out to proceed to an alternate. Emphasis is placed on proper applicaton of rudder and aileron, avoidance of a skid, and continuing of climb integrity. Control is basically with rudder, with only enough aileron to keep wings level. Improper use of aileron during asymmetric thrust operation can cause excessive drag and stall at marginal airspeeds for aircraft configuration and flight situation. Proper rudder application will eliminate the requirement for aileron in maintaining aircraft control except at marginal minimum control speeds.

Returning to Land After Failure

One of two situations is presented when an engine fails on takeoff:

- Under adverse weather conditions, it may be necessary to proceed to an alternate or to an approach fix from which an instrument approach must be made; or
- The airplane must circle the field and land on the same or a different runway.

In either event, the airplane must be climbed to, normally 500 feet AGL or safe obstacle clearance altitude, whichever is higher, at V2 speed. Maximum power should be maintained as long as necessary, gear UP with a positive rate of climb is established, level-off at 500 feet AGL or safe obstacle clearance altitude, accelerate to chart maneuver speed for 18° flaps ("V-RETURN" speed + 20 knots), extend flaps to 18°, and begin circle to land.

NOTE: If loss of engine occurs with high ambient temperature during an 18° flap takeoff, it may be necessary and/or desirable to retract flaps to 8° at V2 + 10 knots, accelerate to chart maneuver speed for 18° flaps ("V-RETURN" speed + 20 knots), then lower the flaps to 18°.

TAKEOFFS (cont'd.)

Returning to Land After Failure (cont'd.)

Take enough time and make the pattern wide enough to insure all landing requirements are complied with, necessary systems are functioning properly, and the landing check is completed. Rudder trim should be used as required and removed just prior to flare. Place gear down opposite touchdown point, extend flaps to 26°, and circle at chart maneuver speed for 26° flaps (not less than 26° flaps REF + 15 knots). On base or when turning final, slow to 26° flaps REF + 10 knots + wind additives.

A landing made with 26° flaps instead of 45° flaps will require approximately 750 feet more runway with DRY conditions and 875 feet more with WET conditions.

NOTE: Refer to Chapter 3 - NORMAL OPERATING PROCEDURES, Section 3-100 for chart representation of runway length requirements for appropriate landing gross weights.

ENGINE FAILURE AT OR ABOVE V1

IF RETURNING TO LAND: After reaching chart maneuver speed for 18°, extend flaps to 18° and turn to runway of intended landing. Lower gear opposite touchdown point. Extend flaps to 26° (maneuver speed), not less than 26° flap REF speed + 15 knots. On or turning final, slow to 26° flap REF + 10 knots + wind additives.

NOTE: If loss of engine occurs with high ambient temperatures, it may be necessary and/or desirable to retract flaps to 8° at V2 + 10 knots, accelerate to chart maneuver speed for 18°, then lower flaps to 18°.

AFTER TAKEOFF CHECKLIST
WHEN OUT OF 10,000 FEET.

FOR EXTENDED CLIMB: Continue acceleration to VFS + 50 knots and reduce power to climb (normally not less than 1,500 feet AGL or 1,000 feet above obstacle clearance altitude, whichever is higher).

COMPLETE ENGINE FIRE/FAILURE CHECKLIST.

At VFS speed, establish climb attitude, reduce power to METO.

Continue acceleration to VFS speed or progress sheet "V-Return" speed + 20 knots (18° flap maneuver speed) if returning to land.

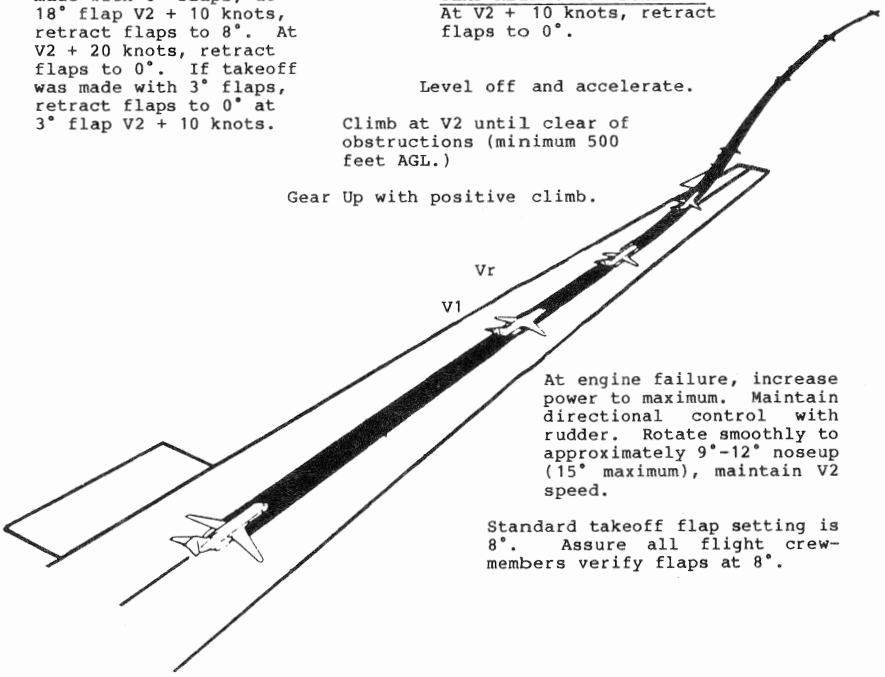
NOTE: If takeoff was made with 8° flaps, at 18° flap V2 + 10 knots, retract flaps to 8°. At V2 + 20 knots, retract flaps to 0°. If takeoff was made with 3° flaps, retract flaps to 0° at 3° flap V2 + 10 knots.

FLAP RETRACTION SCHEDULE
At V2 + 10 knots, retract flaps to 0°.

Level off and accelerate.

Climb at V2 until clear of obstructions (minimum 500 feet AGL.)

Gear Up with positive climb.



At engine failure, increase power to maximum. Maintain directional control with rudder. Rotate smoothly to approximately 9°-12° noseup (15° maximum), maintain V2 speed.

Standard takeoff flap setting is 8°. Assure all flight crewmembers verify flaps at 8°.

AREA DEPARTURE

The trainee shall adhere to actual or simulated ATC clearances and properly use available navigation facilities and equipment.

When making a tunnel departure, generally at 200-250 knots, low departure altitudes are attained quite rapidly. Reduce power somewhat before reaching 400 to 500 feet below the desired altitude. Otherwise, because of the high rates of climb, the altitude will be overshot. The power required to maintain airspeed and altitude varies with gross weight, altitude and temperature. On obtaining climb clearance, advance throttles to climb power and accelerate to enroute climb speed in level flight or in shallow climb (300-500 FPM).

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INFLIGHT MANEUVERS & PROCEDURES

General

Most of the inflight maneuvers that follow are graded by the check pilot to established tolerances that vary with the experience level of the trainee, with FAR requirements as to the proficiency that should be demonstrated, and with existing conditions. Grading criteria vary with the type of maneuver. For example, some problems allow altitude to vary (+ or -) 50 or 100 feet; problems containing minimum altitudes allow no descent below such minimums. Typical of the criteria for grading training proficiency are the following:

- Ability to maintain altitude (+ or -) 100 feet.
- Ability to maintain airspeed within (+ or -) 5 knots.
- Smoothness and coordination of turns.
- Constant degree of bank.
- Recovery of turns within 5° of pre-determined heading.
- Ability to maintain heading within 5°.
- Judgment.

The following are demonstrated and/or practiced:

- Turns with and without spoilers.
- Mach buffet.
- Max. endurance and range procedures.
- Manual reversion (third elevator procedures).
- Steep turns. Pilot flying will adjust power as necessary to maintain 250 knots.
- Approaches to stalls.
- Specific flight characteristics.

Normal Climb

Establish climb power (94.0% HP RPM or 480° EGT).

Maximum Departure Speeds

- 200 knots in airport traffic area (except within TCA).

- 200 knots under the floor and within the lateral limits of a TCA.

- 250 knots below 10,000 feet (domestic). For international flights, use value depicted on airway chart, terminal arrival chart, approach chart, or air regulations for the particular country.

- 250 knots above 10,000 feet to FL270. M.70 to above FL270.

- 300 knots above 10,000 feet for ATC convenience.

- 250 - 270 knots turbulence airspeed.

Single Engine Enroute Climb Speeds

If an extended climb is required, due to inability to return for an immediate landing at departure airport, increase airspeed to obtain best single engine enroute climb speed. Generally, this speed is equal to VFS plus 50 knots or as given in table below. Speeds are rounded off.

GROSS WEIGHT (1,000 lbs.)	60	65	70	75	80	85	87
Single-Engine Climb Speed (Flaps 0°) (KIAS)	190	200	205	215	220	230	235

INFLIGHT MANEUVERS & PROCEDURES (cont'd.)

Normal Cruise

The airplane should be leveled off with climb power maintained until cruise airspeed or Vmo (recommended fuel conservation cruise is 300 knots) is attained, then cruise power should be set (490° EGT maximum).

Turns With and Without Spoilers

Turns at varying bank angles should be accomplished at high and at maneuvering speeds. The trainee should note that in banks exceeding 30° the angle of attack is more noseup at slow speeds than at high speeds and that more power may be required to maintain speed. Also, relatively small pitch variations at high airspeeds cause large changes in IVSI indications.

Turn practice improves trainee's smoothness, instrument scan pattern, ability to keep airplane in trim, and altitude and airspeed control.

Turns should be made with speed brakes extended to varying degrees and with various flap configurations.

After the trainee is familiar with roll rate and control pressures with normal spoiler action, spoiler isolate switches should be used to permit turn demonstration with ailerons alone. It should be noted that roll rate is approximately double with spoilers in use. The necessity for smooth and minimum control pressure with spoilers in use must be emphasized to the trainee, especially at high speeds, at high altitude, and in turbulence.

MTC Demonstration

In cruising flight, at the highest practicable altitude (such as 25,000 feet), trim and adjust thrust for flight at Vmo. Note mach trim compensator indicator light and note absence of pitch trim change. Slow aircraft, turn mach trim off and accelerate to within 5 knots of Vmo. Do not retrim, but note "tucking" (pitch down) tendency as the higher mach numbers are approached. Return the mach trim compensator switch to NORMAL upon completion of this demonstration.

Maximum Endurance & Range Demonstration

Steep Turns

(Minimum 10,000 feet Above Terrain In Aircraft)

Steep turns shall consist of a 45° banked turn of 180° or 360° in each direction. Altitude, airspeed, and angle of bank in turn should remain constant. Power is adjusted as necessary to maintain 250 knots.

Establish 250 knots cruise configuration. Trim aircraft for hands off (approximately 2,000 lbs. fuel flow per engine). Start normal, smooth turn. At 30° bank, check airspeed and altimeter trends. Add slight amount of power (100 lbs. fuel flow per engine).

Establish 45° bank and hold it constant. Scan the instrument panel. The primary instrument is the attitude gyro; however, watch for trends on the altimeter, rate of climb indicator, and airspeed indicator.

Keep bank constant. Lead roll-out heading approximately 15°. Reduce power slightly going through 30° bank on recovery or reversal. The airplane will tend to climb as you roll out of turn. Be smooth, scan; do not trim while in turn.

INFLIGHT MANEUVERS & PROCEDURES (cont'd.)

Approaches to Stalls

General

(Minimum Altitude 10,000 Feet Above Terrain In Aircraft)

Approaches to stalls will be accomplished using different configurations of flaps and from straight and level, or level turning flight. The important factor is the trainee recognizing the approaching stall and taking timely corrective action. It is important to know that thrust in jet aircraft has little effect on lowering the stall speed (as compared to propeller aircraft, since a propeller creates lift by induced airflow). The stall and angle of attack at stall is essentially the same power-on or power-off for jet aircraft.

Approaches to stalls (to stick-shaker), may be accomplished in the clean, takeoff, or landing configuations. The takeoff configuration approach to stall normally will be accomplished while in a 20° banked turn.

Approach to Stall (Clean Configuration)

- Bug ---------- V2 for 18° Flaps
- Trim Speed --- Maneuver Speed 0° Flap
- Gear --------- UP
- Flaps -------- 0°
- Power -------- IDLE
- Bank --------- 0°

Establish level flight with aircraft in clean configuration. Retard throttles to idle. Maintain heading and altitude keeping wings level. Monitor attitude, altimeter, and vertical speed indicators closely. Use stabilizer trim until airspeed decelerates to trim speed, then discontinue trimming. Maintain altitude by gradually increasing angle of attack until stick shaker actuates. Smoothly apply maximum power while lowering the nose to 5° to 10° above the horizon, command flaps to 18°. As airspeed approaches V2, smoothly rotate aircraft to approximately 10° to 12° nose up, maintaining V2. Climb to original altitude at V2, level-off, accelerate to V2 plus 10 knots, retract flaps to 8°; at V2 plus 20 knots, retract flaps to 0°. When the airspeed accelerates through 160 knots, reduce power. (Normally, in this configuration, stall warning occurs at an airspeed higher then V2; therefore, recovery is almost immediate and no altitude need be lost.)

NOTE: On training and checks, one approach to stall is accomplished in a 15-30° bank turn. The following paragraph reflects this requirement as applied to the takeoff configuration maneuver. If only one configuration is used during a check (others waived), it must be in a turn.

INFLIGHT MANEUVERS & PROCEDURES (cont'd.)

Approaches to Stalls (cont'd.)

Approach to Stall (Takeoff Configuration)

- Bug --------- V2 for 18° Flaps
- Trim Speed -- V2
- Gear -------- DOWN
- Flaps ------- 18°
- Power ------- IDLE
- Bank -------- 15° - 30° (As specified)

Establish level flight with aircraft in takeoff configuration. Retard throttles to idle; as airspeed slows to 160 knots, establish a 15° to 30° bank in either direction. Maintain altitude and constant degree of bank. Monitor attitude, altimeter, and vertical speed indicators closely. Use stabilizer trim until airspeed decelerates to trim speed, then discontinue trimming. Maintain altitude by gradually increasing angle of attack until stick shaker actuates. Smoothly apply maximum power while lowering nose to 5° to 10° above horizon, roll wings level and command flaps to 18°. As airspeed approach V2, smoothly rotate aircraft to approximately 10° to 12° nose up, maintaining V2. With a positive rate of climb, retract gear. Climb to original altitude at V2, level off, accelerate to V2 plus 10 knots, retract flaps to 8°, at V2 plus 20 knots, retract flaps to 0°. When the airspeed accelerates through 160 knots, reduce power.

Approach to Stall (Landing Configuration)

- Bug ---------- V2 for 18° Flaps
- Trim Speed --- Vref for 45° Flaps
- Gear --------- DOWN
- Flaps -------- 45°
- Power -------- 85% HP RPM
- Bank --------- 0°

Establish level flight with aircraft in landing configuration. Set power at 85% HP RPM. Maintain heading and altitude, keeping wings level. Monitor attitude, altimeter, and vertical speed indicators closely. Use stabilizer trim until airspeed decelerates to trim speed, then discontinue trimming. Maintain altitude by gradually increasing angle of attack until stickshaker actuates. Smoothly apply maximum power while lowering the nose to 5° to 10° above the horizon and command flaps to 18°. As airspeed approaches V2, smoothly rotate aircraft to approximately 10° to 12° nose up, maintaining V2. With a positive rate of climb, retract gear. Climb to original altitude at V2, level off, accelerate to V2 + 10 knots, retract flaps to 8°, at V2 + 20 knots, retract flaps to 0°. When the airspeed accelerates through 160 knots, reduce power.

Engine Shutdown and Relight

(Minimum 4,000 Feet Above Terrain In Aircraft)

As an individual problem or in combination with other maneuvers, an engine shut down may be simulated at any time during training or may be actually shut down at check pilot discretion for training. Simulate an engine failure or fire. Trainee will identify and shut down the engine. Complete the Engine Failure checklist.

Utilizing the Airstart checklist, return shut down engine to normal operation.

SPECIFIC FLIGHT CHARACTERISTICS

Boost-Off Flight

At approximately 250 knots, cut off both hydraulic systems. Make 30° banked turns in each direction. Make descending and climbing turns. Note "dead band" in elevator control and over-controlling tendency when using electric elevator trim. While reinstating hydraulic systems, avoid any control input as "bump" may be encountered.

Dutch Roll

(Minimum 10,000 Feet Above Terrain in Aircraft)

"Dutch Roll" is characteristic of all swept-wing aircraft. It occurs as a result of excessive "yawing" of the aircraft. It can be induced by the pilot by using excessive rudder inputs or by turbulence. Generally, it is a combination of these two factors which upsets the directional stability of the aircraft and causes dutch roll.

If the aircraft is yawed to the right, the left wing (being swept back) advances into the relative wind, thereby increasing lift. At the same time, the right wing is receding and being partially blanked out by the fuselage, thereby reducing lift. This unbalance of lift causes a roll in the direction of yaw. The induced drag of the advancing wing, the exposure of fuselage side area into the relative wind, and the built-in directional stability of the particular aircraft type all act to attempt to return the aircraft to directional and lateral stability resulting in a yaw roll in the opposite direction. The aircraft will continue to "dutch roll" alternately right and left either increasing or decreasing in severity depending on the aircraft type and/or the action of the pilot. The BAC 1-11, if left alone, tends to "dampen out" after a few oscillations.

This maneuver is accomplished to afford training in the recognition of dutch roll and the corrective action to be taken.

Set airspeed bugs to landing reference speed, and establish landing configuration. Set power and establish a straight-ahead landing descent of approximately 500 FPM. Induce dutch roll by alternately yawing the aircraft left and right then releasing rudder. (The instructor must be alert to prevent oscillations with a bank angle greater than 15° to prevent excessive aerodynamic loads on the vertical fin and empennage.)

Recovery is accomplished by engaging the autopilot yaw damper if it is operational. If not, recover manually by use of ailerons only by quickly "knocking down" the rising wing with a series of aileron inputs of short duration. Keep feet on rudder; however, do not use any rudder inputs.

Maximum Sink Rate Recovery

The maximum "sink rate" acceptable during a final approach for landing is 1,000 FPM. The sink rate should not exceed 1,000 FPM below 1,000 feet above the field elevation or lower. If exceeding a 1,000 FPM sink rate while still above 1,000 foot altitude above field elevation, the pilot should readjust power and flap configuration in order to reestablish the aircraft in the proper approach profile. To emphasize the danger inherent in high sink rate/power-off approach, stressed is the fact that the average "spin-up" time to go from flight idle to 95% thrust on the Spey engine is approximately 5 seconds.

Accomplish the following maneuver: Compute and set landing reference speed. Establish level flight initially with wing flaps at 18°, then gear down and 45° flaps; reduce power to flight idle. Maintain Vref speed, descending at least 2,000 feet. At a predetermined altitude, takeoff thrust should be applied (note time to "spin-up" and altitude loss); landing configuration and Vref speed should be maintained. Note loss of altitude. When positive climb is indicated, retract flaps and gear in normal go-around sequence.

SPECIFIC FLIGHT CHARACTERISTICS (cont'd.)

Emergency Descent

(Minimum Aircraft Termination Altitude 10,000 Feet Above Terrain)

An emergency descent, when practical, should be commenced from high altitude using simulated unexpected decompression, cabin altitude warning, or pneumatic systems failures as causes necessitating the emergency descent. Normally, the maneuver is commenced from cruise configuration with or without the autopilot engaged.

In actual practice, the decision to initiate an emergency descent at Vmo speed should be made only after having carefully considered the following possibilities:

- Possible structural damage may have occurred to the aircraft and it would therefore, be unwise to descend at high speed.

- The aircraft may be overstressed during descent, entry, or recovery.

- Passengers may be thrown about and injured, especially during initial entry.

- Possibility of collision with other aircraft during a high speed, high angle descent through many altitudes.

Once a decision to descend is made, proceed as follows:

If Emergency Descent Must be Made:

Pilot Flying:

- Disengage autopilot, if engaged.

- Retard throttles to idle, smoothly begin descent, rolling into a moderate (30°) bank, if desirable.

- Extend speedbrakes as nose eases through the horizon.

- Accelerate towards Vmo/Mmo, approximately 10° pitch down.

Pilot not flying:

- Don oxygen mask, 100% oxygen.

- Turn seat belt and no smoking signs on. Squawk 7700, advise ATC.

Pilot flying:

- Don oxygen mask, 100% oxygen.

- 1,000 feet before desired altitude, start recovery.

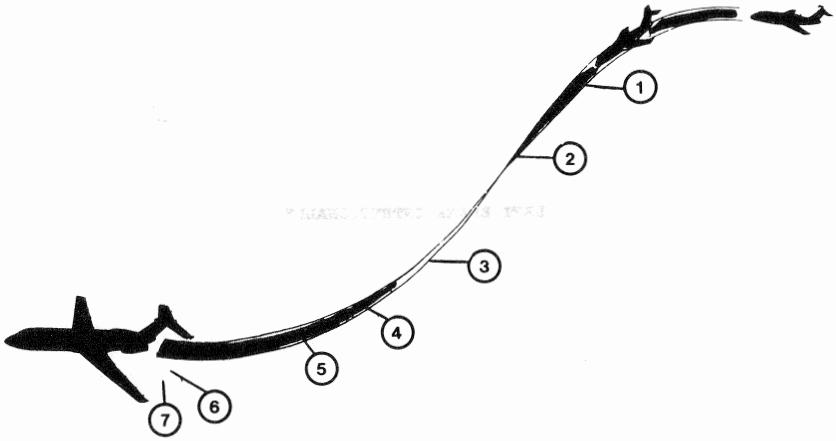
- Avoid abrupt or excessive control movements or tailplane trim.

- Use PA to advise cabin use of oxygen no longer necessary.

EMERGENCY DESCENT

IF AN EMERGENCY DESCENT MUST BE MADE:

- All flight deck crewmembers don oxygen masks, 100% oxygen. Speakers & interphone - ON.
- Throttles - CLOSE.
- Autopilot - OFF.
- Speed brake handle - 20°.
- Seat Belt/No Smoking Sign - ON.
- Roll into moderate (30°) bank or descend straight ahead.
- If structural integrity satisfactory, accelerate toward Vmo/Mmo - approximately 10° pitch down.
- Passenger Oxygen Knob - PULL.
- Transponder - CODE 7700 - Advise ATC.
- Make PA: "Ladies & gentlemen pull down & use your oxygen masks. No smoking please."



1. Obtain altimeter setting.
2. Call passing through each 5,000 feet of altitude.
3. Avoid abrupt or excessive control movements or tailplane trim.
4. 2,000 feet above desired level-off altitude start reducing rate of descent.
5. 1,000 feet above desired level-off altitude, reduce speed and begin level-off - speed brake 0°.
6. Use P.A. to advise cabin use of oxygen no longer necessary.
7. Level off at desired altitude - advance throttles and stabilize speed.

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NORMAL, ABNORMAL AND ALTERNATE PROCEDURES

During proficiency training and checks, the trainee must be able to demonstrate the proper use of and procedures for as many systems and situations as the person conducting the training/checks finds necessary to determine adequate knowledge of and ability to perform such. During training sessions, all appropriate procedures/maneuvers must be covered. These normal, abnormal, and alternate procedures are detailed and explained in the Normal Operating Procedures, Emergency and Abnormal sections and in the individual system sections of the Pilot's Handbook.

The training curriculum includes: Pressurization, Pneumatics, Air Conditioning, Fuel & Oil, Electrical, Hydraulic, Flight Controls, Anti-icing & Deicing, Autopilot, Stability Augmentation, Autopilot & Other Approach Aids, Stall Warning & Avoidance Devices, Airborne Radar Devices, System Malfunctioning or Failure: Electrical, Hydraulic, Flight Controls, Flight Instruments, Landing Gear, Flaps, Navigation and Communications.

EMERGENCY PROCEDURES

During Proficiency training and checks, the trainee must be able to demonstrate the proper use of and procedures for as many systems and situations as the person conducting the training/checks finds necessary to determine adequate knowledge of and ability to perform such. During training sessions, all appropriate procedures/maneuvers must be covered. Procedures for emergency situations are detailed in the Emergency section of the BAC 1-11 Pilot's Handbook. The trainee should have adequate knowledge of the location of all emergency equipment in the aircraft.

Where procedures contain "IMMEDIATE ACTION" items, the pilot should commit those items to memory, leaving "Secondary Action" items for checklist accomplishment.

Training will be given in at least the following emergencies:

- Engine emergencies.
- APU emergencies.
- Electrical emergencies.
- Electrical fire and smoke.
- Smoke from air conditioning.
- Flight deck fire.
- Passenger cabin fire.
- Smoke removal.
- Hydraulic failures.
- Flight controls, malfunctions, and failures.
- Landing gear failures.
- Rapid decompression and emergency descent.

AREA ARRIVAL

The trainee shall adhere to actual or simulated ATC clearances and properly use available navigation facilities and equipment.

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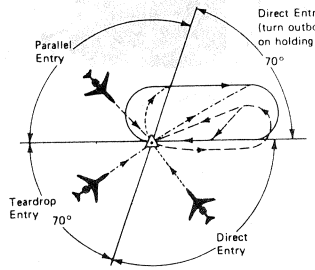
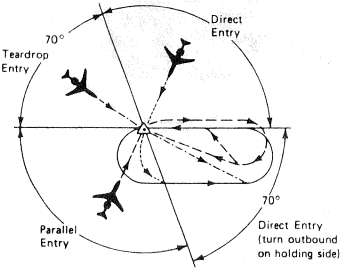
HOLDING PATTERNS

Holding may be accomplished utilizing any radio navigational aid (VOR station, VOR intersections, ADF tracks, localizers at compass locators, etc.). Important to the training/checking on this maneuver are: maintenance of heading, altitude and airspeed prior to arrival at the holding fix (slow down approximately 3 minutes before ETA), proper entry into the pattern, and correctly holding within the prescribed airspace.

Check time entering the pattern, then time the first outbound leg, adjusting subsequent outbound legs to obtain the correct inbound time (1 minute 14,000 feet and below, 1-1/2 minutes above 14,000 feet). Observe applicable bank and IAS restrictions. Descent in the holding pattern may be accomplished clean or with wing flaps in the 18° position at the pilot's discretion.

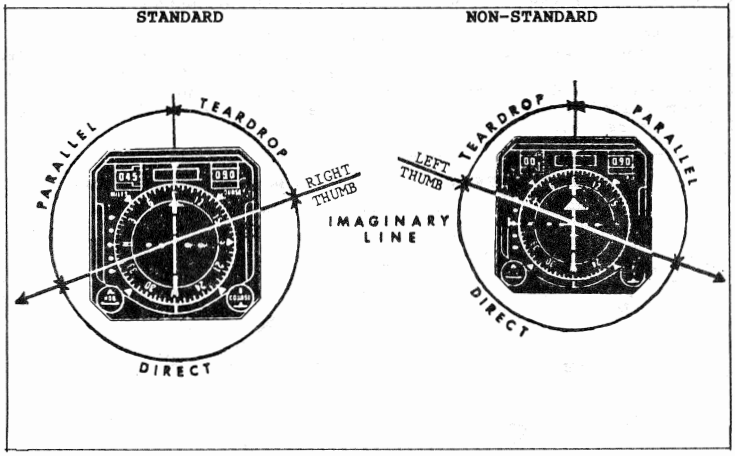
STANDARD PATTERN	NON-STANDARD PATTERN
	
---Direct entry procedure: turn right and fly the pattern.	---Direct entry procedure: turn left and fly the pattern.
.-.Teardrop procedure: proceed on outbound track of 30° to holding course, turn right to intercept holding course.*	.-.Teardrop procedure: proceed on outbound track of 30° to holding course, turn left to intercept holding course.*
_ _Parallel procedure: parallel holding course, turn left and return to holding fix or intercept holding course.	_ _Parallel procedure: parallel holding course, turn right and return to holding fix or intercept holding course.

*Holding procedures outlined on these pages are those recommended by the FAA. Since, in the short time allocated to flying the outbound teardrop, it is impractical to concisely maintain the 30° (or less) track specified, a heading should be flown which should not exceed the 30° track. Known winds should be taken into consideration.

HOLDING PATTERNS (cont'd.)

Type of entry pattern is determined by which segment (teardrop, direct, or parallel) holding radial falls in.

"T" for Thumb and Teardrop (Teardrop quadrant on same side as Thumb).



DESCENT AND APPROACH AWARENESS PROCEDURES

CREW COORDINATION

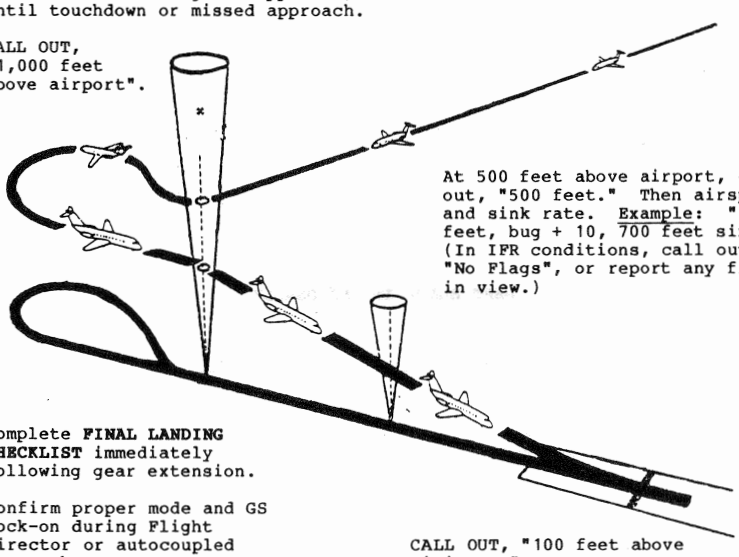
CALL OUT: "Through 18,000 feet". Set and crosscheck altimeters.
THREE (3) RINGS: Pre-Arrival signal should be given prior to 10,000 feet during descent to land.
CALL OUT: "Through 10,000 feet".

Check and monitor approach plates for frequencies, airport elevation, MDA or DH, missed approach procedures, descent rates, etc.

CALL OUT any deviations from normal, programmed altitude, airspeed or descent rates throughout approach, until touchdown or missed approach.

CALL OUT: "1,000 feet to go" above or below all assigned altitudes during climb and descent.

CALL OUT, "1,000 feet above airport".



At 500 feet above airport, call out, "500 feet." Then airspeed and sink rate. Example: "500 feet, bug + 10, 700 feet sink." (In IFR conditions, call out, "No Flags", or report any flags in view.)

Complete **FINAL LANDING CHECKLIST** immediately following gear extension.

Confirm proper mode and GS lock-on during Flight Director or autocoupled approaches.

Final Fix inbound - LOM crosscheck instruments. Check correct altitude at GS interception.

CALL OUT, "100 feet above minimums."

CALL OUT, "Minimums" and either runway in sight or no contact.

Capt. calls "Missed Approach" if necessary.

NOTE: 1. All altitude calls shall be made regardless of the operation of the altitude alerter.

2. At that point on the instrument approach when the flying pilot transitions to visual cues the non-flying pilot should monitor and call out rates of descent and airspeeds.

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INSTRUMENT PROCEDURES AND APPROACHES

Instrument approaches are accomplished using all the various types of radio aids during training; some may be accomplished in a procedures trainer or the simulator rather than in the aircraft. However, a trainee may be called upon at any time to execute any type of approach.

In the following material, only the ILS let down is discussed in detailed text due to the airplane handling during any type of approach, precision or non-precision, circling, engine-out, etc. Differences in procedures, such as flap management, airspeeds, etc., are covered in Chapter 3 and Chapter 18 of this manual. Especially, each trainee and line pilot must be familiar with the pictorial profiles for each approach type.

The profiles depict a nearly ideal situation, a "textbook" approach. Often vectoring, the pilot's own navigation, or a particular situation inserts the aircraft into the profile in other than an ideal position. A straight-in approach requires more planning on flap and speed management than does one with a turn-in to final. An approach without a glideslope does not give the same flap and gear extension clues as does a full ILS, etc.

An ILS is more "cut and dry" than is a non-precision approach. Each type of non-precision approach, each non-precision approach to a particular airport runway, requires study to determine how it fits against the profile. Where should the gear and approach flaps be extended, where should the approach airspeed be established, where should timing commence and what time interval should be used? These are answers that must be established for each approach before it is commenced. Thorough knowledge of the ingredients of each particular approach plus concise piloting helps to remove the "non" from non-precision approaches.

Proper execution of a non-precision approach requires some flexibility in flap usage, i.e., possible use of a different setting at a particular point than that depicted on the profile. Example: When 26° flaps will be used on a circling approach, it is permissible to use 45° to descend more quickly to MDA, then retract to 26° for the circle. On a timed approach, different speeds from those pre-planned must be taken into consideration.

Two items should be remembered on a backcourse ILS approach: (1) The front course should be inserted in the course window of the CDI, and (2) the GPWS glideslope mode should be inhibited to prevent spurious radio signals from triggering an unintentional warning.

Each radio used in orientation, navigation, and approach procedures should be tuned to the proper frequency and identified as correct. The trainee should accomplish as much of this as necessary to become completely familiar with the equipment and associated procedures. During problems which simulate line flying procedures, s/he may ask the check pilot/instructor to tune and identify stations for him/her. Care should be taken that the correct compass indicator pointer selections are made, i.e., ADF position selected during ILS approaches, VOR position selection during VOR approaches, crossover switches as desired, etc.

The instrument approach begins when the airplane is over the initial approach fix for the approach procedure being used and ends when the airplane contacts the runway or completes the transition to a missed approach.

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STABILIZED APPROACH FACTORS

The "stabilized approach" requires the aircraft in landing configuration at proper airspeed and sink rate by 500-800 feet above the ground on a straight-in approach, by 300 feet on a circling approach.

Approach procedures must be standardized as much as is possible consistent with existing conditions. Following are definitions and explanations of approach components:

Stabilized Approach	Stabilized airspeed, stabilized sink rate, and a constant profile.
Normal Sink Rate	500-700 FPM.
Reference Speed (Vref or "Bug" speed)	The 1.3 Vs speed. As certificated, the the airplane is assumed to be at this speed 50 feet above the runway threshold in landing configuration. This speed value from the V-chart is placed under the bug on the airspeed indicator, as are mechanical types of speed additives, such as when landing with hydraulic failure (3rd elevator). During strong and/or gusty wind conditions, certain increments are added as wind additives but they are <u>not</u> placed under the bug.
Initial Maneuvering	18°
Approach Flap	26°

During maneuvering to final approach, target airspeed is the maneuver speed for the appropriate flap setting from the V-chart.

Landing Flap	45° (26° single engine).
Gust	Difference between reported wind and peak gusts. Example: Wind 320° at 20K with gusts to 30K. Gust equals 10K.
Gust <u>Factor</u>	One-half (1/2) of gust = 5 knots.
Headwind <u>Component</u>	Effective headwind (steady state). Example: Runway heading 260° wind 320° at 20 knots, gusts to 30 knots Headwind component, 10 knots.
Headwind <u>Factor</u>	One-half (1/2) of headwind component = 5 knots.
Final Approach Speed	Vref (bug) speed plus 5 knots plus wind (headwind and gust) additives. Minimum speed is normally bug plus 5 knots, maximum speed is normally bug plus 15 knots. Abnormal approaches (zero flap, significant windshear reported or suspected, etc.) may require modification of these values.

STABILIZED APPROACH FACTORS (cont'd.)

The MINIMUM final approach speed should not be less than Vref plus 5 knots on a normal 45° flap (or a 26° flap single engine) approach.

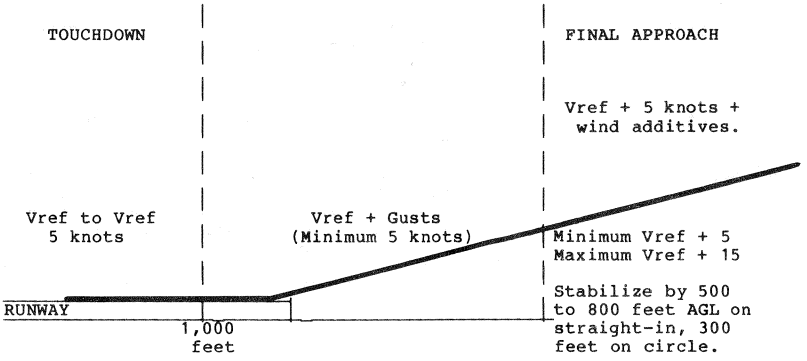
The MAXIMUM total additives should not normally be greater than 15 knots. Dissipate additives in the final portions of the approach, retaining only bug plus the gust additive (minimum 5 knots) until in the target flare speed envelope.

Target Flare Speed	The target flare speed envelope is the transition sector, when reducing speed from stabilized approach speed to touchdown. When reducing descent rate prior to touchdown, target speed is Vref (bug) plus any gust factor, with a minimum of bug plus 5 knots. In the example below, target flare speed is 120 knots.
Touchdown Target	1,000 feet beyond the approach end of the runway, at speed something less than Vref (such as -5 knots).

EXAMPLE OF ADDITIVES

Final approach at 60,000 lbs., flaps 45°, wind 20 knots gusting to 30 knots.

Set bug to		115 knots
Headwind Factor (1/2 of component)	10 knots	
Gust Factor (1/2 of gusts)	5 knots	
Procedural additive	5 knots	
Total of possible additives	20 knots	
Maximum permissible additive		15 knots
Speed on final approach		130 knots
Target Flare Speed		120 knots



GROUND PROXIMITY WARNINGS

If a **TERRAIN** warning is activated, the crew must immediately focus its attention on terrain proximity and make a rapid determination as to the validity of the warning. If the crew cannot immediately determine that the warning is invalid, the pilot must rapidly apply maximum power while simultaneously rotating to an attitude of 15° nose up. The warning will cease when the dangerous situation no longer exists. If the warnings do not stop, the pilot must climb until terrain clearance is assured and a positive determination can be made of the cause of the warnings.

These actions altering the flight path to stop the warning should be initiated immediately; smoothness should be of no concern if adding maximum power and rotating the aircraft is determined to be necessary to gain terrain clearance. They are especially appropriate under the following conditions:

- While conducting approaches over unlighted terrain; maneuvering for an approach at night; or in instrument conditions.

- When established on an approach where vertical guidance is unreliable.

- In maneuvering for, or established on, an approach when ambient conditions such as turbulence or wind shear cause the approach to become unstabilized.

If a **GLIDESLOPE** warning is activated between the altitudes of 1,000 and 150 feet AGL, application of power sufficient to bring the airplane back up toward the glideslope beam center will cancel the warning when it is less than 1.3 dots below the glideslope. The allowable deviation increases to 2.7 dots at 50 feet AGL. This deviation causes an offscale deflection on the glideslope deviation scale.

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CATEGORY I APPROACHES

Category I approaches are predicated on the use of dual flight directors or a single flight director and the approach coupler.

Pilots must utilize the "Monitored" Approach System on Category I approaches. All pilots should be thoroughly familiar with the following "Monitored" approach procedure:

F/O calls "1,000 feet AGL." At this point, the First Officer takes control of the throttles, assumes airspeed control, and monitors autopilot in the Auto GS (ILS) mode. He also makes the callouts, using the standard approach phraseology.

The Captain monitors the entire approach -- autopilot, speed, altitude, other instruments, etc. He maintains his hand at the base of the throttles. When the First Officer calls, "One hundred above minimums", the Captain diverts his scan to outside. When the First Officer calls, "At minimums", one of the following takes place:

- If proper visual cues identifiable with the approach end of the runway are clearly visible, a descent to a landing can be made at a normal descent rate which will allow touchdown within the touchdown zone, and flight visibility is not less than prescribed minimum, the Captain calls, "I've got it," simultaneously lifting the First Officer's hand from the throttles. The Captain then disconnects the autopilot and lands the aircraft.

- If proper visible cues identifiable with the approach end of the runway are not present, or the aircraft is not in a position from which a normal approach to the runway can be made, the Captain calls, "Missed approach," and the First Officer disconnects the autopilot and makes a go-around.

- If the Captain makes no callout, the First Officer disconnects the autopilot and executes a go-around.

If the Captain elects to continue the approach, the First Officer continues to monitor his flight instruments until touchdown, giving speed and sink information and warning against deviations from the normal descent and speed profile.

If, after the Captain assumes control for landing and visual contact is lost or a go-around is required, the Captain will execute the go around. The First Officer monitors the instruments for deviation from a normal go-around profile.

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ILS APPROACH PROCEDURES

Normal Two-Engine ILS Approach

The appropriate ILS frequency should be selected well in advance of its intended use, 10 minutes if possible. Monitor for station identification and normal operation, checking the flag alarm system as well as other indications. All other instruments and cockpit components which are to be used during the approach should be checked and set.

The appropriate approach plate should be referred to and all applicable supplementary aids tuned and identified. Outbound, procedure turn, and inbound headings and altitudes should be studied. The appropriate minimums and pull-up procedure should be noted.

Prior to starting the approach, the Descent/In Range Landing checklists shall be accomplished and the airplane slowed to the approach speed as outlined in this manual. This will enable the flight crew to give undivided attention to tracking the localizer and glidepath during final approach.

On being cleared for descent or an approach (or outbound from the outermarker), the airspeed should be slowed between a maximum of 200 knots and chart maneuver speed for 18° flaps, the wing flaps should be extended to 18°, the Landing checklist completed, and approach discussed. Aircraft maneuvering to the final approach course will vary according to whether radar vectors, check pilot vectors, or the trainee's own navigation is being used. Normally, the aircraft should intercept the final course at least 5 miles from the outermarker. Proper interception of the localizer and glideslope simplify and increase the accuracy of the ILS approach. After intercepting the localizer and at 1-1/2 dots below the glideslope, lower the gear DOWN, call for Landing checklist. At 1/2 dot below the glideslope, extend 26° flaps. At final fix inbound extend 45° flaps. (45° flap extension can be delayed to 1,000 feet AGL. Stabilize by 800-500 feet AGL.) Allow the airspeed to bleed to Vref plus 10 knots, plus necessary wind additives. Stabilize final approach speed by 800-500 feet above field elevation.

Monitor speed and rate of sink closely. Regardless of whether approach is being made with raw information, the integrated instrument system, or the autopilot coupler, the localizer needle and glideslope pointer are the main indicators to be monitored. These are the end result; other instruments and aids are only a means of obtaining this result. All instruments and indications must be continually cross-checked. Significant deviations of planned sink rate, speed or power may indicate windshear.

Two-Engine Missed Approach

If contact is not established upon reaching minimum altitude/missed approach point, or if a missed approach must be made for any other reason, advance thrust to maximum, rotate toward V2 speed (maximum 15° pitch), retract flaps to 18°, with positive rate of climb, raise the gear. Proceed as with normal takeoff.

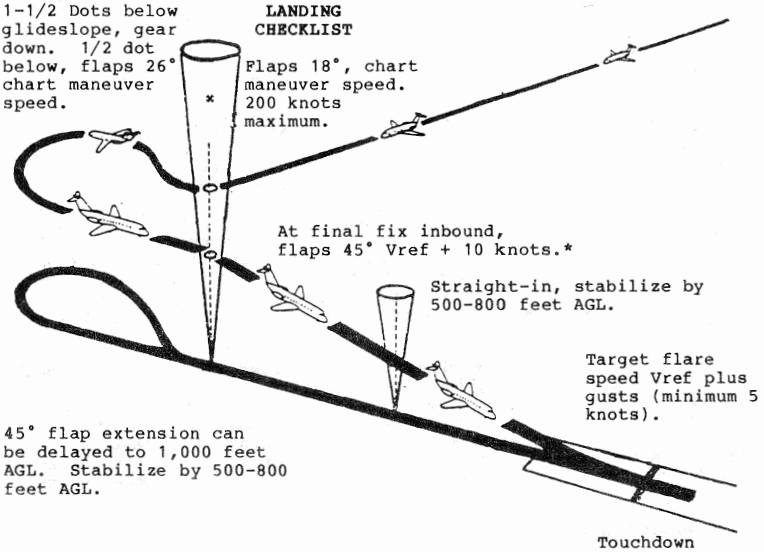
NOTE: Other reasons for which a missed approach might be required would be an aircraft or system problem, not in position for a normal approach to a landing which might require maneuvering close to the ground, too high and too close to the threshold which might require an excessive sink rate, etc.

(cont'd.)

NORMAL ILS APPROACH AND LANDING

250 knots maximum below 10,000 feet.

DESCENT/IN RANGE CHECKLISTS COMPLETED


1-1/2 Dots below glideslope, gear down. 1/2 dot below, flaps 26° chart maneuver speed.
LANDING CHECKLIST
Flaps 18°, chart maneuver speed. 200 knots maximum.
At final fix inbound, flaps 45° Vref + 10 knots.*
Straight-in, stabilize by 500-800 feet AGL.
Target flare speed Vref plus gusts (minimum 5 knots).
45° flap extension can be delayed to 1,000 feet AGL. Stabilize by 500-800 feet AGL.
Touchdown Target 1,000 feet.

CIRCLING APPROACH

Fly ILS approach and circle with gear down, flaps 26°.
Chart maneuver speed.
On base or turning final, flaps 45° Vref + 10 knots.*
Stabilize by 300 feet.

MISSED APPROACH

Maximum power.
Rotate towards V2. (REF + 10 knots = V2.)
Flaps 18°.
Gear up with positive rate of climb.
Clean up as in normal climb.
AFTER TAKEOFF CHECKLIST

*PLUS WIND ADDITIVES

ILS APPROACH PROCEDURES (cont'd.)

One Engine Inoperative ILS

If an engine should fail inbound, raise the wing flaps to 26° and fly final approach at Vref for landing with 26° flaps plus 10 knots plus wind additives necessary. A landing made with 26° flap instead of 45° will require approximately 750 feet more runway with dry conditions, 875 feet with wet conditions. A chart in Chapter 3, Section 3-100 presents representative runway length requirements for appropriate landing gross weights.

One Engine Inoperative Missed Approach

If a missed approach must be made, power is advanced to maximum, rotate to REF + 10 knots (V2 - GO) for 8° flaps (approximately 9°-12° nose up), retract flaps to 8°, and with a positive rate of climb, retract gear. Hold REF + 10 knots (maximum 15°) to 500 feet or safe obstacle clearance, whichever is higher. Accelerate to REF + 20, retract flaps, accelerate to VFS speed. Establish climb and set METO power (26° flaps REF + 10 knots; 8° flaps V2).

ONE ENGINE ILS APPROACH AND LANDING

250 knots maximum below 10,000 feet.

DESCENT/IN RANGE CHECKLISTS COMPLETED

1-1/2 dots below glideslope, gear down. 1/2 dot below, flaps 26° chart maneuver speed.

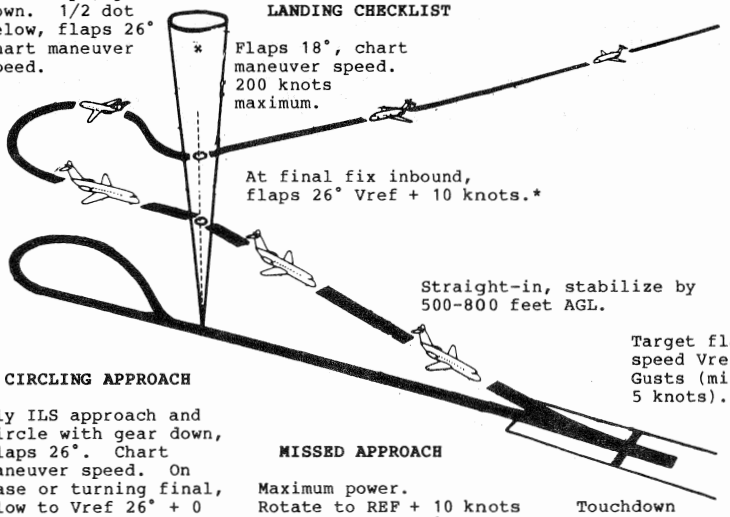
LANDING CHECKLIST

* Flaps 18°, chart maneuver speed. 200 knots maximum.

At final fix inbound, flaps 26° Vref + 10 knots.*

Straight-in, stabilize by 500-800 feet AGL.

Target flare speed Vref + Gusts (minimum 5 knots).



CIRCLING APPROACH

Fly ILS approach and circle with gear down, flaps 26°. Chart maneuver speed. On base or turning final, slow to Vref 26° + 0 knots.*

Stabilize by 300 feet AGL.

NOTE: If APU operating under 10,000 feet (not in icing conditions) configure pressurization system for Engine Bleeds Off Landing.

MISSED APPROACH

Maximum power.
Rotate to REF + 10 knots (V2-GO), flaps 8°.
Gear up with positive rate of climb.
Maintain REF + 10 knots to 500 feet (or clear of obstructions).
Accelerate to REF + 20 knots.
Retract flaps.
Accelerate to VFS.
Establish climb. Set METO power. 26° flaps REF + 10 knots = 8° flaps V2.

In the event of a missed approach or rejected landing, the flight director should be switched to the OFF or GYRO mode as soon as practical.

AFTER TAKEOFF CHECKLIST

Touchdown target 1,000 feet.

One engine landing made with 26° flaps. 750 feet more dry runway required with 26° instead of 45°, 875 feet with wet runway. Chart in Chapter 3, Section 3-100 lists runway required vs. gross weight.

*PLUS WIND ADDITIVES

ASR/PAR PROCEDURES

The only airborne radio equipment required for radar-controlled approaches is a functioning radio receiver and transmitter. By means of radar, the controller closely follows the flight path of aircraft and issues instructions to align it with the centerline of the runway and keep it on course until the pilot can complete his approach and landing by visual reference to the surface. There are two types of radar approaches, precision and surveillance. These are covered in paragraphs below; actual aircraft letdown procedures are covered under ILS Approach Procedures paragraphs.

The Surveillance Approach (ASR) is one in which the controller provides navigational guidance in azimuth only. The pilot is furnished headings to fly to align his aircraft with the extended centerline of the landing runway, but since the radar information used for surveillance approach is less precise than that for a precision approach, the accuracy of the approach will not be as great and weather minima will be higher. The pilot will be given a point at which to start his descent based on a desirable glide angle and the approach speed of the aircraft. He will be advised of distance from the end of the runway each mile on final and recommended altitudes will be furnished at each mile. Navigational guidance is provided until the aircraft is one mile from the approach end of the runway. At this point, he is given his distance from the runway and directed to execute a missed approach if he does not have runway in sight at landing minimums.

NOTE: The company has removed PAR from its operations specifications. A PAR approach would not be normally made, but could be used in an emergency.

The Precision Approach (PAR) is one in which the controller provides azimuth and elevation navigational guidance to the pilot. The aircraft follows the same flight path to the instrument runway as with the ILS approach.

Pilots are told when to anticipate glideslope interception, when to begin descent, and they may be given a rate of descent based on glideslope angle and the aircraft's approach speed. If the aircraft deviates above or below the glideslope or to left or right of runway extension line, the pilot is given the amount of deviation and asked to adjust descent or heading to correct. Range from touchdown is given at least each mile. If the aircraft deviates outside of specified safety limits in azimuth or elevation, and the pilot does not have ground reference, missed approach instructions are given. Navigational guidance during an approach is given until the aircraft passes over the approach end of the runway at which time he is directed to take over visually and complete his landing.

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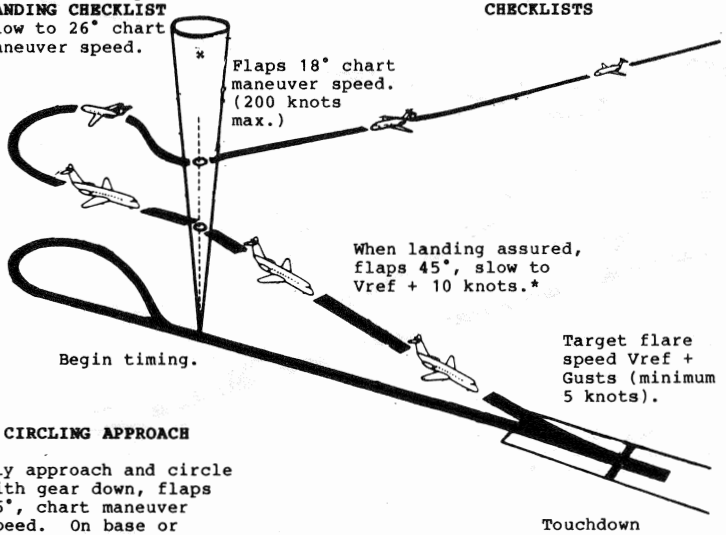
NORMAL VOR/LOC/NDB/LDA/ASR/BK CRS ILS NON-PRECISION APPROACHES

After procedure turn (or approximately 5 miles from final fix), gear down, flaps 26°.
LANDING CHECKLIST
Slow to 26° chart maneuver speed.

250 knots below 10,000 feet.

DESCENT/IN RANGE CHECKLISTS


Flaps 18° chart maneuver speed. (200 knots max.)
When landing assured, flaps 45°, slow to Vref + 10 knots.*
Begin timing.
Target flare speed Vref + Gusts (minimum 5 knots).
Touchdown target 1,000 feet.

CIRCLING APPROACH

Fly approach and circle with gear down, flaps 26°, chart maneuver speed. On base or turning final, flaps 45°, Vref + 10 knots.*

Stabilize by 300 feet AGL.

MISSED APPROACH

Maximum power.
Rotate towards V2 (REF + 10 knots = V2), flaps 18°, gear up with positive rate of climb.

AFTER TAKEOFF CHECKLIST

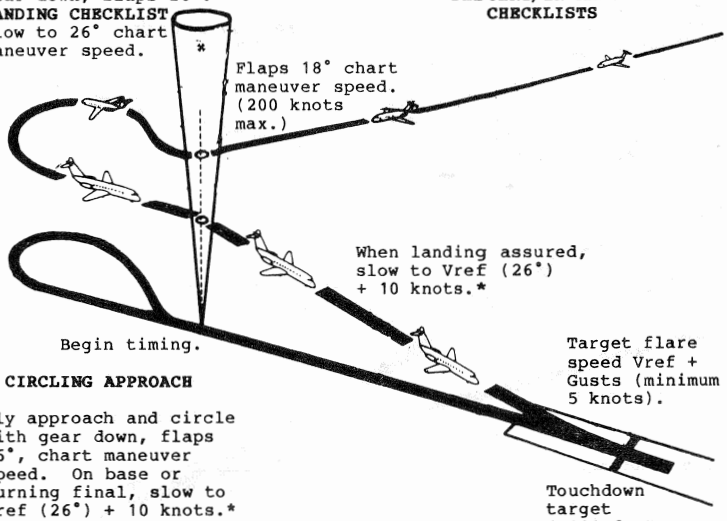
*PLUS WIND ADDITIVES

ONE-ENGINE VOR/LOC/NDB/LDA/ASR/BK CRS ILS NON-PRECISION APPROACHES

After procedure turn (or approximately 5 miles from final fix), gear down, flaps 26°.
LANDING CHECKLIST
Slow to 26° chart maneuver speed.

250 knots below 10,000 feet.

DESCENT/IN RANGE CHECKLISTS


Flaps 18° chart maneuver speed. (200 knots max.)
When landing assured, slow to Vref (26°) + 10 knots.*
Begin timing.
Target flare speed Vref + Gusts (minimum 5 knots).
Touchdown target 1,000 feet.

CIRCLING APPROACH

Fly approach and circle with gear down, flaps 26°, chart maneuver speed. On base or turning final, slow to Vref (26°) + 10 knots.*

Stabilize by 300 feet AGL.

MISSED APPROACH

Maximum power.
Rotate to REF + 10 knots (V2-GO).
Flaps 8°.
Gear up with positive rate of climb.
Maintain REF + 10 knots (or clear of obstructions).
Accelerate to REF + 20 knots.
Retract flaps.
Accelerate to VFS.
Establish climb.
Set METO power. 26° flaps REF + 10 knots = 8° flaps V2.

In the event of a missed approach or rejected landing, the flight director should be switched to the OFF or GYRO mode as soon as practical.

AFTER TAKEOFF CHECKLIST

One engine landing made with 26° flaps: 750 feet more dry runway required with 26° instead of 45°, 875 feet with wet runway. Chart in Chapter 3, Section 3-100 lists runway required vs. gross weight.

CIRCLING APPROACH AND LANDING

Two-Engine Circling Approach

The two-engine circling approach configuration is gear down, flaps 26°. Use chart maneuver speed for flaps 26°. During circle, the flaps may be extended to 45° anytime on base or base to final turn at which time aircraft will be slowed to Vref for 45° flaps plus 10 knots plus wind additives. This speed should be stabilized by 300 feet above field elevation.

One-Engine Circling Approach

The one-engine circling approach configuration is the same as the two-engine. On base or turning final, slow to Vref for landing until 26° flaps plus 10 knots plus wind additives.

VISUAL SIMULATOR CIRCLING APPROACH PROCEDURES

General

The visual system permits training/checking for the circling approach and landing maneuver. This may be accomplished by utilizing one of two procedures, designated "45" and "80". Two non-directional beacons and one VOR, all "phantom" stations, have been established in the navigational area to facilitate flying these procedures. The simulator is programmed so that the aircraft can be automatically positioned over any of these stations. The appropriate approach plate shall be utilized.

The visual system's ceiling and visibility controls are set as appropriate for circling minima (100 feet above lowest authorized MDA and 2 miles visibility). Wind component on landing runway is set above 10 knots to require circle. The circling approach to landing can be accomplished by one of the following methods:

Circling Procedures "45" and "80"

Make NDB, ASR, or VOR approach that will overhead beacon for final fix (or simulator can be positioned overhead). Descend to circling MDA. With visual sighting, fly downwind over runway, establishing drift angle on final approach and while tracking down runway. Visual contact should be maintained throughout the landing approach. Then,

Method 1 - Procedure "45"

At end of runway (cockpit cutoff angle), make standard rate turn (approximately 25° bank) off runway (+ or -) drift correction. Fly constant airspeed. Hold heading 25 seconds, make standard rate turn to runway heading (+ or -) drift correction.

Method 2 - Procedure "80"

At end of runway (cockpit cutoff angle), make standard rate turn (approximately 25° bank angle) 80° off runway (+ or -) drift correction. Fly constant airspeed. Turn immediately at standard rate to runway heading (+ or -) drift correction.

MDA should be maintained until on base turning final with runway environment in sight. A satisfactory approach includes proper altitude, airspeed, and directional control.

NOTE: Typical procedure depicts NDB/ILS with a landing on the opposite runway.

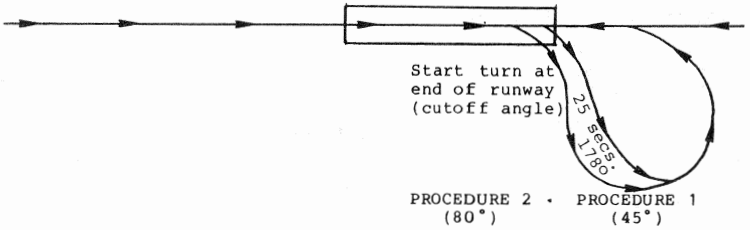
VISUAL SIMULATOR CIRCLING APPROACH PROCEDURES (cont'd.)

Circling Procedures "45" and "80" (cont'd.)

Method 2 - Procedure "80" (cont'd.)

CONSTANT SPEED & STANDARD RATE TURN (APPROXIMATELY 25° BANK)

NDB/ILS



DME PROCEDURES

Distance Measuring Equipment can be used during training/checking to assist in holding, instrument approaches (VOR and ILS), establishing position, and computing accurate ground speeds.

Select the frequency of an in-range Vortac (VOR/DME) station. Check the identification. The ID tone is transmitted in Morse Code after every 4th VOR station identification. The DME signal is higher in tone than that of the VOR. The numeral readout now supplies slant range distance in nautical miles to be used in conjunction with desired training procedures.

DME ARC PROCEDURES

Some approaches are made via terminal routes from DME arcs, as depicted on approach charts. These show distance from facility, direction of flight, and start and stop points of arc. Terminal routes to straight-in approaches are diagrammed as such and give bearing and distance to final approach course.

Maintaining Arcs

Under no wind conditions, the aircraft will fly in an exact circle (arc) around the station by maintaining a relative bearing of 90° or 270°. In practice, since wind is generally a factor, a good method for maintaining an arc is to fly a series of short legs, keeping the bearing pointer on or near the wing tip position while maintaining desired range. While proceeding around an arc, and assuming constant wind direction and velocity, drift correction will constantly change.

Intercepting a Radial from an Arc

Set the desired course on the Course Selector. Monitor the rate of bearing pointer progression while flying the arc, remembering that the interception angle will be approximately 90°. As a rule-of-thumb, a lead point when intercepting a radial from a 10-mile arc (no wind) would be 6°.

Intercepting an Arc from a Radial

Interceptions may be made from the course either inbound or outbound. A turn of approximately 90° is required to place the bearing pointer on the wing tip toward the station, with the distance equal to the desired arc. The turn must be led by sufficient distance to rollout on the correct arc. As a rule-of-thumb, with a 250 knot ground speed, the amount of lead would be 1-1/4 miles.

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INTEGRATED INSTRUMENT, AUTOPILOT USAGE

Use of the various flight director and autopilot modes vary in training and flight checking. For the most part, coordination of the modes and settings of the autopilot and each pilot's flight director system should be effected for continual cross-checking.

The OFF mode of the flight director might be used throughout an approach so that instrument indications would be similar to those of an aircraft not equipped with integrated flight equipment. This is known as a "raw data" approach. However, full use should generally be made of all the aids available to the pilot during training and checking. Typical usage for an ILS approach is outlined in following paragraphs.

During maneuvering to the final approach course, the OFF mode could be used or, especially if being vectored, the HEADING mode of the flight director and the HEADING SELECT feature of the autopilot can be used. The HEADING knob of the flight director is used not only to select the heading for that system but also for the autopilot (in conjunction with the HEADING SELECT position).

The heading marker or "bug" is set to the desired heading when being vectored or while maneuvering. When on a 45° intercept, the mode selector is set to V/L for automatic localizer capture. The annunciator will indicate ARM. As the localizer is captured, the flight director command will provide fly-to information to allow localizer tracking. As the glideslope is approached, select GS (or APPR) for capture, then the flight director will provide both azimuth (localizer) and elevation (glideslope) information for tracking. The annunciator window will indicate ENG until glideslope extension is reached at which time EXT will show.

The GS mode is used until minimum touchdown. At this time the autopilot is disengaged and the airplane landed.

In the event of a missed approach or rejected landing, the flight director should be switched to the OFF or GYRO mode as soon as practicable.

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MISSED APPROACH POINT (MAP)

PAR/ILS

The missed approach point (MAP for precision approaches) is the geographic point where the glideslope intersects the decision height. For a PAR approach, decision height is determined in the cockpit either as read on the altimeter or as observed by the radar controller, whichever occurs first.

The MAP for an ILS approach will normally be very close to the middle marker if one is installed. In some cases, however, there is a considerable distance between the two. For this reason, the middle marker should be used only as a reminder that you are very near the MAP. Determination of the MAP is made solely with reference to the altimeter, radio altimeter, and glideslope indicator.

ASR

The radar controller is required to discontinue approach guidance when the airplane is at the MAP or one mile from the runway, whichever is greater. From the pilot's standpoint, perform the missed approach whenever the controller instructs you to do so. This will be no less than one mile from the runway.

Localizer

The MAP for a localizer approach is not necessarily the same as for the corresponding ILS approach. The depiction on the approach chart supports the ILS and not the localizer procedure. The timing table, when included, will show the distance from the LOC final approach fix to the MAP. For most approaches this distance is to the threshold of the runway. The common method of determining the MAP is by timing from the final approach fix, though other methods may be used (DME, middle marker, etc.).

Other Non-Precision

The MAP for all other non-precision approaches is as depicted on the approach chart. If the procedure has a final approach fix, the MAP may be well short of the runway threshold or at the runway threshold. For on-airport facilities (VOR or NDB) which do not have a final approach fix, the facility itself is the MAP and in most cases is past the runway threshold.

It is erroneous to assume that you will be in a position to make a normal landing if you reach MDA and the MAP simultaneously. When the MAP is at or beyond the runway threshold, you must reach MDA prior to arrival at the MAP if a normal final approach is to be made.

Executing Missed Approaches

Pilots conducting instrument approaches utilize visual cues as they become available during the approach. At the DH or MDA the pilot should, however, be aware that due to shallow fog, snow flurries, or heavy precipitation, these cues may be lost after descent below the DH or MDA. If visual cues are lost after DH or MDA, the pilot should immediately execute the published missed approach procedure as required by Federal Aviation Regulations. Missed aproaches, when properly executed, involve little loss of altitude below the altitude at which the missed approach is "started."

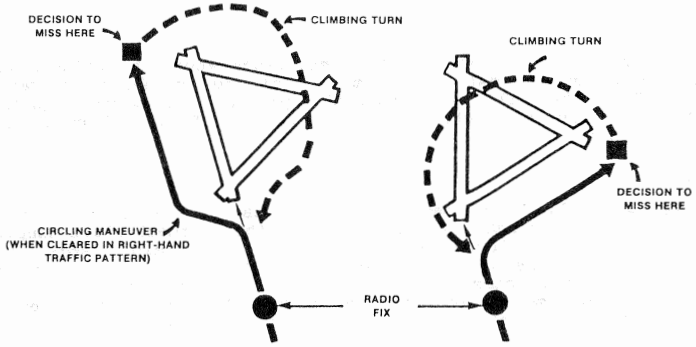
(cont'd.)

MISSED APPROACH POINT (MAP) (cont'd.)

Executing Missed Approaches (cont'd.)

Missed approach procedures for straight-in approaches rarely present a problem. Conducting a missed approach when not established on a final approach course should be as follows:

If a missed approach is required at any time while circling, perform a climbing turn toward the runway of intended landing (this maneuver will position the aircraft over the airport and climbing). When over the airport and climbing, turn (in the shortest direction) to the missed approach fix and proceed with published procedure.



LANDINGS

Normal Landing

The basic approach pattern is fundamental to all approaches. No matter how or where the approach pattern is joined, the aircraft should be flown according to the basic pattern from that point to touchdown.

Downwind Leg

Complete Descent/In Range checklists prior to entering the traffic pattern. Enter normally at 1,500 feet above the terrain, with speed between chart maneuver speed for 18° flap and 200 knots. Extend flaps to 18°. Landing gear DOWN opposite approach end of runway, accomplish Landing checklist, extend 26° flaps, decrease airspeed to chart maneuver. Extend downwind leg to approximately 10-15 seconds beyond the end of the landing runway, begin normal descent turning base leg.

Base Leg

Flaps are extended to 45° at 1,000 feet AGL and airspeed decreased to Vref for 45° flaps plus 10 knots plus wind additives. On final, this speed should be stabilized by 300 feet above field elevation. (Engine and airfoil anti-icers should be left on for landing if icing conditions exist near the ground.) A target rate of descent of 500-700 feet per minute should be set up on base leg.

Final Approach Leg

As turn is made to final, the airplane should be in the "approach slot" with the touchdown target selected 1,000 feet beyond the runway threshold. Proper glideslope angles (2-1/2° to 3°) and sink rate (500-700 FPM) must be established early in the approach to avoid high sink rates close to the ground.

CAUTION: The turbine "spin-up" time to accelerate from flight idle to 95% is approximately 5 seconds. AVOID POWER OFF APPROACHES.

On final, landing flaps should be 45°, with speed programmed to Vref plus 10 knots plus wind additives. This speed should be maintained until entering the flare envelope. Excessive speed consumes valuable runway -- this, plus an excessive hold off requires excessive braking at the rollout end, or may cause a hard landing. Below approximately 200 feet altitude, maintain normal sink rate and no less than target flare speed.

At flare, if touchdown does not occur, ease off on control column back pressure and gently "put the aircraft on". After touchdown and with both main gears on the runway, deploy the spoilers and engage thrust reversers while smoothly lowering the nose to the runway. Maintain directional control with the rudder. Thrust reversers should not normally be operated at high power during the landing roll and should be placed in idle reverse at 70 knots, then cancelled at 50 knots.

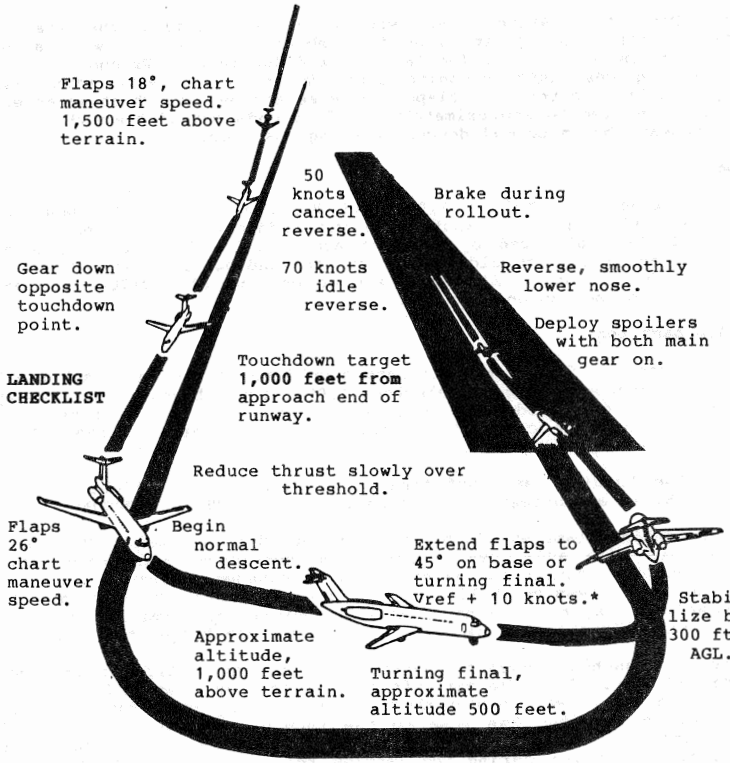
NOTE: If loss of directional control is experienced after engaging reverse, it is normally better to cancel on the reverse of both engines than to attempt to regain control with asymmetric reverse.

Brakes (including any differential braking necessary) may be applied any time after touchdown but normally should be used in the latter part of the landing roll in order to prevent excessive brake wear and overheating.

The pilot not flying should guard the control column as soon as the nosewheel contacts the runway to prevent nose rise during spoiler deployment and reversing. (Care should be exercised against excessive forward pressure which could cause a lifting effect on the main wheels.) After returning engines to forward thrust, retract spoilers, retract flaps to 18° for taxi. Complete the After Landing checklist.

NORMAL VFR LANDING

DESCENT/IN RANGE CHECKLISTS
250 knots maximum below 10,000 feet.
200 knots maximum in airport traffic area.


Flaps 18°, chart maneuver speed. 1,500 feet above terrain.
50 knots cancel reverse.
Brake during rollout.
Gear down opposite touchdown point.
70 knots idle reverse.
Reverse, smoothly lower nose.
Deploy spoilers with both main gear on.
LANDING CHECKLIST
Touchdown target 1,000 feet from approach end of runway.
Reduce thrust slowly over threshold.
Flaps 26° chart maneuver speed.
Begin normal descent.
Extend flaps to 45° on base or turning final. Vref + 10 knots.*
Stabilize by 300 ft. AGL.
Approximate altitude, 1,000 feet above terrain.
Turning final, approximate altitude 500 feet.

REJECTED LANDING PROCEDURE

Maximum power.
Rotate toward V2 (REF + 10 knots = V2).
Flaps 18°.
Gear Up with positive rate of climb.
Clean up as in normal climb.

AFTER TAKEOFF CHECKLIST.

LANDINGS (cont'd.)

Crosswind Landing

On final approach, establish a crab angle to maintain aircraft on the extended centerline of runway. Maintain crab angle until just before touchdown, then use rudder to align aircraft with the runway.

Keep wings as level as possible. Use only enough bank to maintain zero drift, touching down on the upwind wheels. Do not hold off downwind wheels. Prompt runway contact will greatly aid in stabilization on roll out.

After touchdown and during roll out, aileron correction should only be that necessary to maintain wings level. Maximum input is limited to 15° yoke travel to prevent downwind spoiler retraction and resultant wing lifting. Use spoilers, reverse, and brakes as in a normal landing.

Rejected Landing

Whenever the Captain elects to abandon a landing, s/he should:

- Apply full power immediately. Open the throttles smoothly and positively. (Three to five seconds are required for the engines to accelerate from flight idle RPM to approximately 95% thrust).

- Rotate to a positive rate of climb of approximately 9° to 12° on the artificial horizon.

- Command wing flaps to be raised to 18°.

  CAUTION: AT VERY LOW ALTITUDES, FLAP RETRACTION WILL BE DELAYED SUFFICIENTLY TO INSURE TERRAIN CLEARANCE SHOULD THE AIRCRAFT SETTLE DURING WING FLAP RETRACTION.

- With a positive rate of climb, command landing gear to be retracted.

- When landing is abandoned early in the approach at higher altitudes, the handling of power, flap, and gear may be altered slightly to obtain greater speed and terrain clearance margins when dictated by the situation.

One Engine Approach and Landing

When landing with one engine inoperative, approach and landing techniques are similar to those with both engines operating except that landing is made with 26° flaps and final approach speed is flown at bug speed (1.3 Vs for 26° flaps) plus 10 knots plus wind additives. After touchdown, use single engine reversing, correcting with brakes as necessary for asymmetrical thrust.

A landing made with 26° flaps instead of 45° will require approximately 750 feet more runway with dry conditions, 875 feet with wet conditions. A chart in Chapter 3, Section 3-100 presents representative runway length requirements for appropriate landing gross weights.

ONE ENGINE APPROACH AND LANDING

DESCENT/IN RANGE CHECKLISTS
250 knots maximum below 10,000 feet.
200 knots maximum in airport traffic area.

AFTER TAKEOFF CHECKLIST

Maintain REF + 10 knots (V2-GO) to 500 feet (or clear of obstructions). Level off and accelerate to REF + 20 knots. Retract flaps. Accelerate to VFS. Establish climb attitude. Set METO power.

Flaps 18°, chart maneuver speed. 200 knots maximum.

Chart maneuver speed, 1,500 feet altitude above terrain.

1,500 feet altitude above terrain, gear down opposite touchdown point.

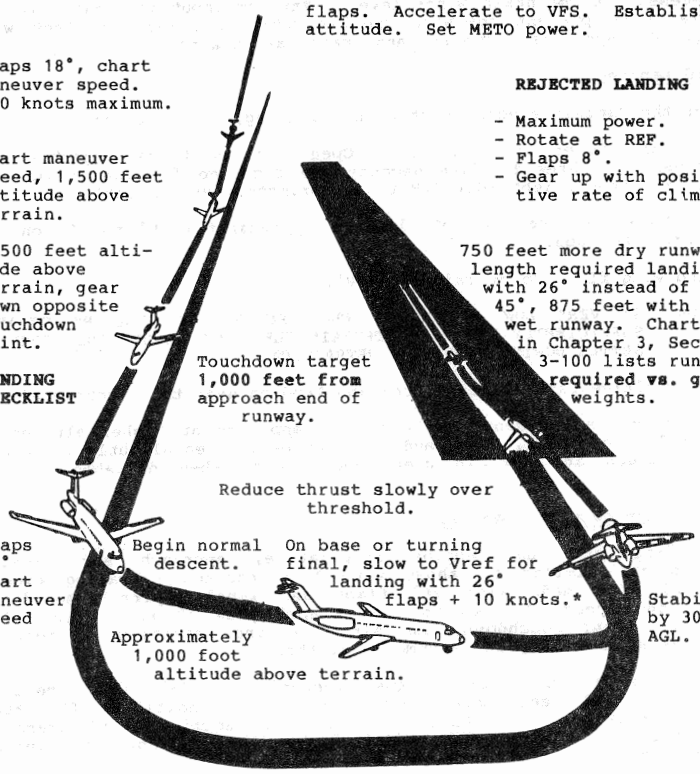
LANDING CHECKLIST

REJECTED LANDING

- Maximum power.
- Rotate at REF.
- Flaps 8°.
- Gear up with positive rate of climb.

750 feet more dry runway length required landing with 26° instead of 45°, 875 feet with wet runway. Chart in Chapter 3, Section 3-100 lists runway **required vs. gross** weights.

Touchdown target **1,000 feet from** approach end of runway.



Reduce thrust slowly over threshold.

Flaps 26° chart maneuver speed

Begin normal descent.

On base or turning final, slow to Vref for landing with 26° flaps + 10 knots.*

Stabilize by 300 ft. AGL.

Approximately 1,000 foot altitude above terrain.

*PLUS WIND ADDITIVES

LANDINGS (cont'd.)

No Flap Approach and Landing

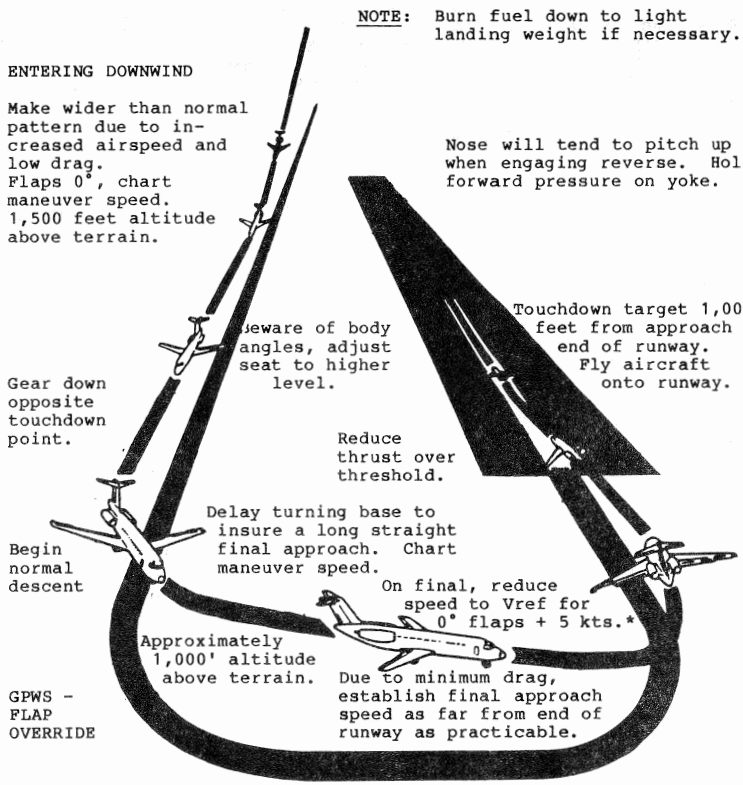
The pilot must always carefully evaluate the condition of the runway to be used as well as the wind and weather factor before making a no-flap landing in line operation. The airspeed bugs are set at Vref for 0° flaps. Fly an extended downwind leg in order to have a long final approach. Set up and maintain proper thrust airspeed and sink rate control early on final approach in order to avoid large corrections close to the ground. The pattern speeds are chart maneuver speeds on downwind and base, and Vref + 5 knots + wind additives on final approach, retaining only any gust factor (minimum 5 knots) entering the target flare speed envelope. After touchdown, the copilot must guard the control yoke fully forward; otherwise, a severe pitch-up might occur when reverse thrust is applied.

NOTE: Select GPWS to FLAP OVERRIDE.

(cont'd.)

NO FLAP APPROACH AND LANDING

DESCENT/IN RANGE CHECKLISTS
250 knots maximum below 10,000 feet.
200 knots maximum in airport traffic area.


NOTE: Burn fuel down to light landing weight if necessary.
ENTERING DOWNWIND
Make wider than normal pattern due to increased airspeed and low drag.
Flaps 0°, chart maneuver speed.
1,500 feet altitude above terrain.
Nose will tend to pitch up when engaging reverse. Hold forward pressure on yoke.
Beware of body angles, adjust seat to higher level.
Touchdown target 1,000 feet from approach end of runway. Fly aircraft onto runway.
Gear down opposite touchdown point.
Reduce thrust over threshold.
Delay turning base to insure a long straight final approach. Chart maneuver speed.
Begin normal descent
On final, reduce speed to Vref for 0° flaps + 5 kts.*
Approximately 1,000' altitude above terrain.
Due to minimum drag, establish final approach speed as far from end of runway as practicable.
GPWS - FLAP OVERRIDE

REJECTED LANDING PROCEDURE
- Maximum power.
- Rotate with reference speed minimum.
- Gear up with positive rate of climb.

CHART MANEUVER SPEED WHILE MANEUVERING, Vref PLUS 5 KNOTS PLUS WIND ADDITIVES ON FINAL.

LANDINGS (cont'd.)

Third System Elevator Landing (Simulated Loss of Both Main Hydraulic Systems)

- At high speeds, reduce pitch-up tendency by reducing speed. Do not attempt to trim the aircraft at high speeds with electric trim tab or selecting emergency elevator to EMERG.

- At 200 knots IAS maximum but not slower than 0° flap maneuvering speed, extend flaps to 18° by setting normal flap selector to 18° and selecting DC hydraulic pump to EMERG FLAPS. Approximately 4 minutes is required to extend the flaps to 18° using the DC pump.

- If necessary, after flaps have reached 18°, top off brake accumulator using DC hyd pump selector held in the BRAKE ACC position.

- Fly at 160 knots IAS with 18° flaps. Plan an elongated pattern to allow stabilization of airspeed and sink rate on a long final approach.

- Set airspeed bugs to Vref for 18° flaps (18° Vref = 45° Vref plus 12 knots).

- Select GPWS to FLAP OVERRIDE.

- If necessary, trim out any nose-down pitch tendency using the electric trim tab before the emergency elevator is selected to EMERG.

- The emergency elevator switch should be selected to EMERG on the downwind leg, checking that the amber emergency elevator light on the forward instrument panel is flashing and the amber emergency elevator hydraulic pressure low light and the red emergency elevator valve failure light on the pedestal are not illuminated.

- Any further out-of-trim forces after engagement of the emergency elevator will have to be held on the control column. Do not actuate the electric trim tab with the emergency elevator engaged.

- On the downwind leg, the landing gear should be lowered (free fall, if required), checking that the three green gear lock lights are illuminated. If the gear was free-fallen, the red door lock light will be illuminated.

- Select standby nosewheel steering switch to ON. Check that the amber low pressure light is not illuminated.

- Fly Bug (Ref) speed plus 20 knots on base leg. Descent on base leg and final is normally 500 to 700 FPM, with a maximum of 1,000 FPM. On final, fly Bug (Ref) plus 5 knots plus wind additives. Touchdown target should be approximately 1,000 feet from the runway threshold. Target flare speed is Bug (Ref) plus any gust factor with a maximum additive of 5 knots. Touchdown at approximately Bug (Ref) speed. Do not hold aircraft off for a grease job.

- Approximately 700 feet more runway is required for landing with 18° flaps than the required runway for landing with 26° flaps.

- On touchdown, spoilers are not available. Lift dumpers are available if hydraulic system No. 1 is normal; full aft travel of speedbrake handle is required to obtain lift dumpers, if operative. Use maximum reverse thrust. Yoke must be guarded forward to minimize nose-up pitch. Use one heavy application of foot brakes using anti-skid. When sufficiently slow, if required, apply hand brakes carefully to prevent skidding (no anti-skid protection). Maintain reverse power until assured of stopping on runway. Below 80 knots, nosewheel steering can be used sparingly; nosewheel steering accumulator contains enough fluid when fully charged for approximately 220° of accumulative turning.

- After landing, pin all landing gear and have aircraft towed.

HYDRAULIC SYSTEMS INOPERATIVE LANDING (3RD ELEVATOR SYSTEM)

DESCENT/IN RANGE CHECKLISTS

Slow to 200 knots.
Flap selector to 18°.
DC pump to EMER FLAPS.
Allow 4 minutes for extension. (Top off brake accumulator, if necessary)

18° flaps (160 knots).

Set bug. Vref 45° + 12 knots for 18°.

Emergency Elevator ON. (Amber & Red light out)

Free-fall gear. (3 green, 1 red light on)

Standby nosewheel steering ON.

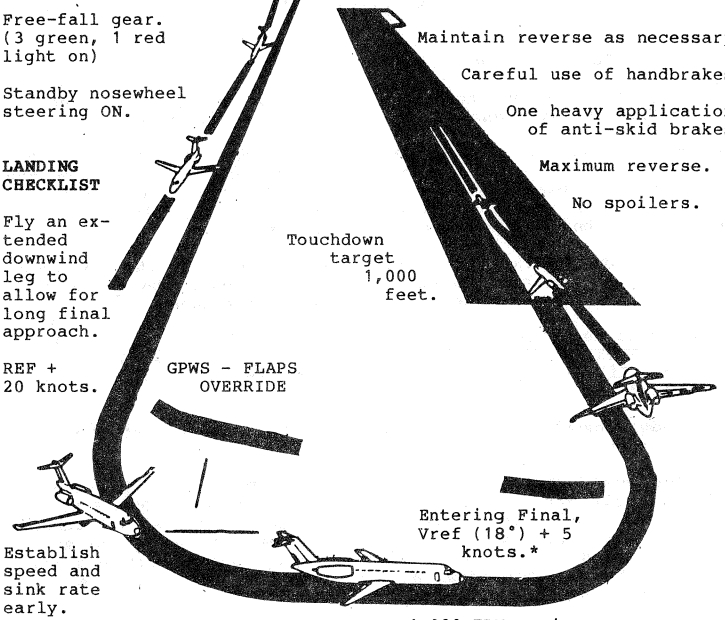
LANDING CHECKLIST

Fly an extended downwind leg to allow for long final approach.

REF + 20 knots.

Establish speed and sink rate early.

500-700 FPM is desired (1,000 FPM maximum).


Maintain reverse as necessary.
Careful use of handbrakes.
One heavy application of anti-skid brakes.
Maximum reverse.
No spoilers.
Touchdown target 1,000 feet.
GPWS - FLAPS OVERRIDE
Entering Final, Vref (18°) + 5 knots.*
1,000 FPM maximum.

AVAILABLE

- Reverse thrust.
- Landing gear (free fall)
- 18° flaps (DC pump)
- 1 application anti-skid brakes.
- 6 applications handbrakes.
- 220° nosewheel steering
- Elec. Elevator Trim/3rd elevator.

LIMITATIONS

- Maximum crosswind 10 knots.
- No spoilers.
- No rudder or tail-plane trim.

*PLUS WIND ADDITIVES